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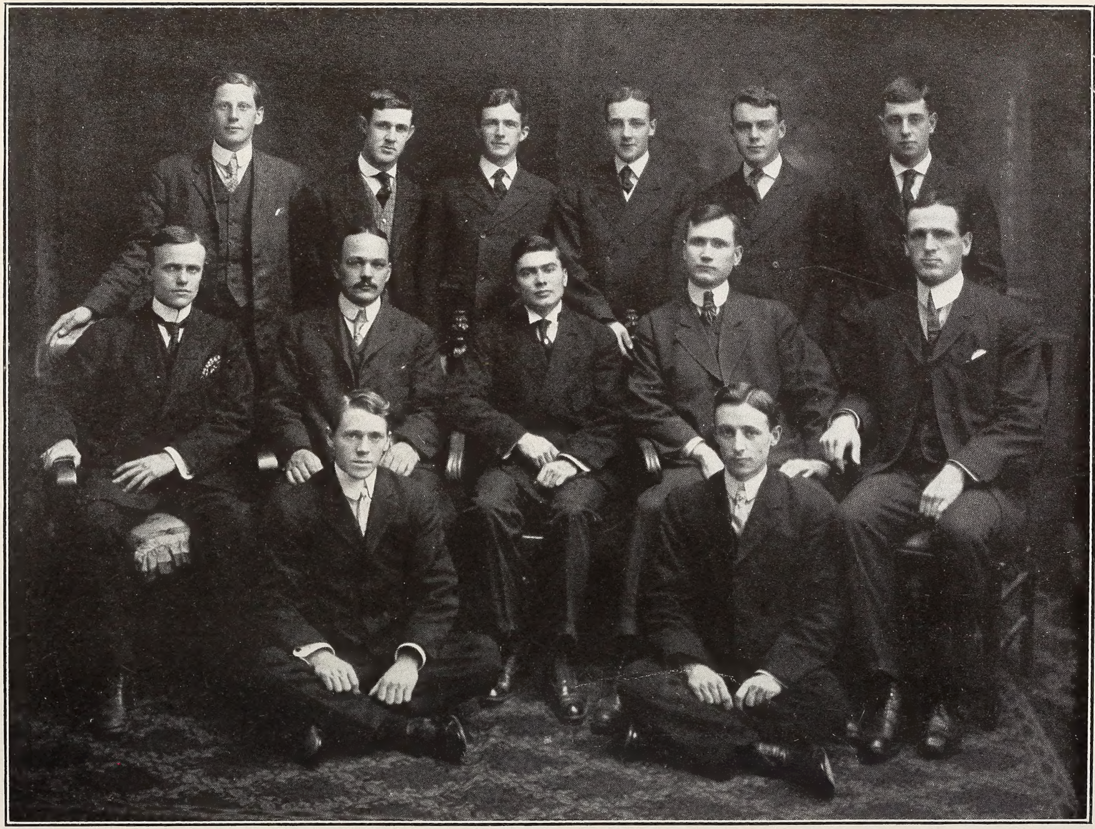

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CANADA'S FERTILE NORTHLAND

R. E. YOUNG, D.L.S.

Mr. Young after thanking the president and members of the Society for the invitation extended to him to address them, spoke as follows:

At the outset I wish to point out to you that I have evidence at considerable length for every statement that I intend to make here. The large map of the Dominion* on my right shows, colored in red, the townships that were surveyed on the 1st January of this year, the townships of which plans have been published. The settlement is, of course, confined to the areas colored in red. You will notice a small patch of darker red color around the city of Winnipeg. That is the land that was surveyed according to a departmental map issued in the year 1873. It is interesting to examine the original because immediately outside the limits of the surveyed townships the land is shown topographically in a very incorrect manner. According to that map the information about the country outside the surveyed area was very limited indeed. There are about 4,500,000 acres of land in that small tract that was surveyed in 1873.

The subject of my story to-day is the portion of the Northwest north of the colored area.

I want to devote a few minutes, if you would allow me, to an explanation of the progress in the colored portion as shown on the large map. There are three reasons why.

When I bring before you in the manner which I shall endeavor to do the facts that I have in my possession to-day the growth in that settled portion will appear surprising and interesting; and the growth that we may expect in the settled portion in the future will show that it is of great importance that we should know and investigate more about the country north of the colored portion. If that region is as good as I think it is, investigation is very necessary, and if it is as bad as some people imagine, it is equally desirable that we should ascertain all that we can about it.

There is another reason why I want to explain a little about this colored portion on the map, and that is because I think I can show you in a very brief way and with very few figures, that the area of land available in the surveyed portion of the Northwest is much more limited than many people imagine.

There is a third reason, a personal one, and perhaps you will allow me to state it, and that is, I was a resident of the Northwest for nearly twenty years and I lived there through all the dark years when we hoped that many things would happen which have since come to pass, and our faith in that country was sorely tried. I like, therefore, to dilate upon the progress that is now taking place and to tell you a little about what we expect will happen in the future.

It is a little difficult to explain these things by figures without it becoming wearisome and I am going to illustrat some of my points by diagram.

First let me point out the railways. There are nearly 7,000 miles of railway on that map in the three prairie provinces. The exact figures were 6,422 on the 1st July last year, and therefore, it will be safe to say that there are 7,000 miles of railway now. When I landed in the Northwest on 1st May, 1880, the railway mileage in the Northwest consisted of a half finished line between Emerson and St. Boniface. We had to cross the Red River into Winnipeg on the ferry. The line was built by laying ties on the prairie and spiking the rails to them and that is all the railway there was.

The population in the settled portion of these three provinces can be safely stated at 1,000,000 people. The Census Bureau has given me an estimate of 6,800,000 as the total population of Canada on the 1st January last so that we have in the three provinces, excluding British Columbia, one-seventh of the population of the Dominion at this date.

Now I want to illustrate by means of diagrams some of the figures to which I will draw your attention. There are 120,000,000 acres on the colored portion of the map to my right and I have converted that into a square on the same scale. I do not know that I could show it in any better way. Here is a square on the same scale representing the colored area on the map (holding up square). The area of land alienated is 86,000,000 acres which is represented by the somewhat smaller square and which I place in front of the larger square. The balance around the edge is what we have left in the surveyed portion of the Northwest. I am giving you round figures although I have the figures exactly. Now let us compare the area alienated with the area under cultivation of 8,500,000 acres represented by this much smaller square. The area under wheat is 5,000,000 acres represented on the same scale by this still smaller square.

This smaller square represents as I say 5,000,000 acres of land but it also represented 100,000,000 bushels of wheat in 1906. Supposing I take the 86,000,000 acres of land and cut off a quarter for the purpose of making a calculation which may seem to be a rather optimistic one. If I scale the 86,000,000 acres down in that way to 65,000,000 acres and divide the 5,000,000 acres into it it will go 13 times. Is it not a fair supposition that we can multiply 100,000,000 by 13 and get 1,300,000,000 bushels of wheat within a reasonable number of years? If you feel inclined to doubt that supposition, gentlemen, there is just one point I ask you to remember: that is selected land. It is not land taken at random over an unexplored country; it is selected land. Over 31,000,000 acres of that land was selected by about 200,000 homesteaders. About the same amount was selected by seven or eight railways to satisfy their land subsidies, selected by expert land examiners; and while I would not pretend to be an authority on this subject and to make the statement that there will be raised annually 1⅓ billions of bushels of wheat, for the purpose of my argument I want to just ask you to turn that amount into dollars and consider it for a moment. We are not taking into account oats, barley, flax or rye, or the cattle products of that country at all. Take that area of land with the wheat which can be grown to a lesser extent even than my figures would give, and it seems a reasonable and safe statement to make that in the time of people now living there will be the equivalent in money of 1,300,000,000 bushels of wheat. Remember there are over 50,000,000 acres of land that have not gone into that calculation. There are 120,000,000 acres of land surveyed and I am only asking you to consider this as applied to 65,000,000 acres.

There is another aspect of this question that I would like to bring to your notice. I have a telegram here from a gentleman at Saskatoon, and he followed that message up by a letter. I got these figures because I knew the gentleman, and I particularly asked him to give me figures that I could absolutely rely upon and quote. I only got figures from that point although similar results can be shown from many other points in the West. I have no interest in Saskatoon in any way; I do not own an acre of land there or anywhere else in the Northwest, and do not expect to. Now this gentleman's statement, which I consider very striking, is:—" 375 acres wheat, net cash yield per acre 14⅓ dollars." It is quite a striking thing to reflect upon. That man goes into that country and farms 375 acres. He spends $6 or $7 in raising wheat on it, and after the crop has been harvested he has over $14 per acre to put into the bank.

Now about the North country. In considering the North country a great many people have the idea that latitude governs the climate. Of course that is absolutely untrue. It is ridiculously untrue, particularly as regards our country. I will go into the climate question in a few minutes. Let me draw your attention to the fact that that northern region is practically all a wooded country. The knowledge we have of that country has been obtained by people who have travelled along the rivers in canoes almost entirely. I would like to ask any gentleman to try and imagine how much valuable knowledge would have been obtained of the great and wealthy province of Ontario by means of travelling along the St. Lawrence, the Ottawa and other rivers as men used to travel in canoes 200 years ago? And yet that is the kind of knowledge that we have about that North country almost entirely.

Let me ask you to notice a small red star on the map, 14 miles outside the arctic circle. That is Fort Good Hope on the Mackenzie river. The statement was made before the Senate Committee last spring which was investigating the North country, that potatoes, cabbages, and onions were grown at Fort Good Hope.

A gentleman, who gave evidence before the Senate Committee last spring, was in my office about a week or ten days ago. He told me that he was at Fort Good Hope last summer and he said: " I saw just as good vegetables growing there as I have seen in the Province of Ontario." The gentleman in question is Mr. Conroy of the Indian Department. The growth of vegetation is rapid, beyond belief to us, in that North country. I will quote you a statement made by Bishop Clut, who I think was stationed at Fort Providence for many years, and who gave evidence before the Senate Committee, which was presided over by the late Senator Scultz, in 1888. He said, speaking of vegetation at Fort Good Hope; " I have observed this phenomenon: Towards 7th or 8th June, vegetation commences, and in five or six days the leaves of the trees had reached their natural size."

I will proceed to tell you what the red spots on this map mean. Those are points where wheat has been grown. They were not selected for any agricultural purpose, because they are points where the fur trade has been carried on by the Hudson Bay Company. Another point I would like to mention to you is that the inhabitants of that country, and there are very few of them, are almost exclusively flesh eaters. They do not eat, and they do not desire to eat, wheat or such products; I want to show you—no doubt many of you have seen it before, but it seems to me important—a sample of Ladoga wheat that was grown at Fort Simpson. Here it is (holding up sample). I got it from Doctor Saunders, Director of Experimental Farms. Fort Simpson is the farthest north of these red points just short of latitude 62 or just about it. That wheat was shown to a gentleman who is accounted an authority on the subject, you could not get a better authority, with the request, " Would you please look at that wheat, but do not refer to the label on the bottle, and tell me what you think of it ? " He examined the sample in the way that men who are experts on wheat often do.

He saw nearly every grain of it. He said: "It is very nice wheat, I would call it good wheat. It has been slightly frosted but I think that wheat would go about 64 pounds to the bushel." Well the label on the sample says, " Ladoga Wheat, grown at Fort Simpson on the Mackenzie river, 62 pounds to the bushel."

Here is a sample of wheat from Fort Vermilion (displaying sample). That also was shown to the same expert. In both instances he expressed his opinion before he knew where either of the samples came from. He said: " That is pretty nice wheat. It is not so nice a wheat as the other, but I think it would make first rate flour; it is good wheat." Now consider for a moment that the area enclosed by these red spots would be larger—I think considerably larger—than the entire province of Ontario. I will just take a moment to enumerate these points. There is Fort Simpson on the Mackenzie river, Fort Providence—and a witness said before the Senate Committee last spring that he had seen wheat ready to cut at Fort Providence on the 28th July, 1906, and it was cut a few days later and good crops of oats and barley—Fort Liard. You see in the Report of the Senate Committee of 1888 that Ex-Judge McLeod gave evidence and quoted from his father's Journal. His father was an official of the Hudson Bay Company and his Journals extend from 1811 to 1849. He said: " Wheat is a sure crop at Fort Liard four times out of five." Then there is Fort Chipewyan. Wheat that was grown there took the highest award I think at the Centennial Exhibition in 1876. Then there is Fort Vermilion, where a flour mill is turning out 35 barrels a day. That mill is electrically lighted and equipped in a modern manner. There were 25,000 bushels of wheat grown at Fort Vermilion in 1906. This farthest point west on the Peace river is Fort Dunvegan. (There are two or three other points—Hudson's Hope and Fort St. John—which I have omitted on account of their being down in the valley). Proceeding with the reference to the wheat points, there are Lesser Slave Lake, Fort McMurray, and Ile a la Crosse. At the latter point Professor Macoun found them growing wheat and grinding it with a horse-power mill in 1875. Then there is Stanley Mission,—150 miles north of Prince Albert on the Churchill river,—Archdeacon McKay gave evidence before the Senate Committee that wheat had been grown for seven years in succession at Stanley Mission. At Cumberland House, Sir John Richardson records that wheat was grown in 1820 when he passed through there. We also have the statements of witnesses before the Senate Committee that wheat has been grown at Norway House, Cross Lake and Nelson House.

There have been a great many statements made about the probable area available in that country for settlement. One gentleman, a member of the Alberta Legislature, Mr. Bredin, said (I am quoting his statement though I think it rather a liberal estimate), that there was 100,000,000 acres of land—he was particularly referring to the area as far east as the Athabaska and west and north of it—available for settlement. Mr. Conroy of the Indian Department, who has travelled over that country a great deal, made the statement that there was as much land in that tract of country as was now settled west of Winnipeg. There is a great deal of evidence existing as to the probable area of land available in that country. The Minister of the Interior had an exploration made, I think it was in 1905, of the country between Pas Mission on the Saskatchewan and Fort Churchill. That party was sent out for the purpose of exploring the country. They were members of the Geological Survey of Canada, and their statement—which I presume can be absolutely relied upon —amounts to this: That there are 10,000 square miles of good clay land between the Pas and Fort Churchill—6,000,000 odd acres of land. A surveyor of the Indian Department who has been around Lac la Ronge told me that he considered the land surrounding its shores just as good as any land south of the Saskatchewan. There has been a great deal of other evidence given about that part of the country which I will not take time to dwell upon. It may be generally stated that south of the Churchill river, west of the Athabaska and Slave rivers and extending as far north as Fort Simpson, and perhaps a little farther, there is a good deal of good land all the way.

Now as to the climate. Mr. R. F. Stupart, the Director of the Meteorological Service of Canada, has devoted a good deal of attention to this subject, and he says that he would consider the mean summer temperature of 57½ degrees was a safe limit up to which you could grow wheat. He said that he would not dogmatize on the subject but that that would, he thought, be a safe limit. I have endeavored to put on that line on the map as near as I could get to it. I admit the information is not complete, but we have done the best we could from the evidence supplied by Mr. Stupart. I will trace a line on the map running from the north-east corner of the province of Manitoba—just outside the spots that I have mentioned—crossing the Mackenzie river about half way between Fort Wrigley and Fort Norman, and then following the eastern slope of the Rockies southerly. During his evidence before the Senate Committee last spring, Mr. Stupart furnished a table giving the summer temperature, and I think it is a very striking thing that the summer temperature of Fort Simpson, Fort Chipewyan and Winnipeg are nearly the same—that is from the 1st June to the 20th August or thereabouts—the summer temperature would therefore be nearly the same as that of Ontario. It is hard to understand or believe that a man may be going about here in summer clothing and that if he could be transported to Fort Simpson in those months that he could wear the same clothing without discomfort. You may say that it is pretty cold in the winter. I do not think there is any doubt about it. It is somewhat colder than the Northwest. There is just one remark that was made by a witness before the

Senate Committee last spring that seems to me to be very pithy and to the point. He said: "Things don't grow in the winter."

If the agricultural possibilities are in that country, the fact that it is a cold climate in the winter won't deter people from settling there. I have read a few unfavorable expressions of opinion about that country but I never heard of anyone saying that it was not a healthy country. I gave you the figures a few moments ago of the net result of growing wheat in the vicinity of Saskatoon. I believe that it would be a reasonably safe statement to make that better wheat can be grown the farther north you go. Many authorities agree that the farther north you go, almost to the northern limit of the wheat growing area, the better the wheat that is grown. I believe that the statement has been made that wheat has been grown at Fort Chipewyan weighing 68 pounds to the bushel. Men have gone into the most undesirable places on the earth's surface in search of gold and to carry on gold mining. They have gone into the hottest and the coldest and the most unhealthy countries for this purpose. Surely there is no amount of gold mining equal to the results obtained at Saskatoon, viz., 14⅓ dollars net per acre?

To meet the point that would arise in a man's mind about the cold winter, first let me introduce to your notice at this stage something that I have prepared for this meeting. I will fasten it to the map so that you can see it in its relation to the subject. This is a map of the Province of Tobolsk in Siberia. It is drawn to the same scale as the map and placed in the same position as to latitude. The southern boundary of the main part of the Province you will note is about 100 miles north of the latitude of Edmonton. That small dark spot, not quite one-third north of the south part of the province, is the City of Tobolsk. That city has a population of 20,427 people. The City of Onsk on the Great Siberian Railway, just on the south boundary and about 100 miles north of the latitude of Edmonton, has a population of 37,470. The City of Tomsk, which is not within the Province of Tobolsk but in an adjoining province and in a little lower latitude than Tobolsk, has a population of 52,005. The population of the Province of Tobolsk was a million and a half of people in 1900. I also have figures here of the population of some eight or ten towns in the Province of Tobolsk. There is one of 1,000, another of 3,000, another of 7,000, one of 8,000, and so on. The farthest north is the town of Bere-zoff with a population of 1,073 and in latitude 63°.50′. In 1900 there were raised in Tobolsk 6,480,000 bushels of wheat, 3,000,000 odd bushels of rye, 972,000 bushels of barley, and 10,617,000 bushels of oats. These figures are from the Encyclopedia Britannica.

All the information I have would go to show that settlement would not extend to the most northerly regions, but still the fact that there were towns of 1,000 people in the northern portion would go to show that there must be something being done there that would support a town of that size. And two-thirds of the way up we find a road marked on the map which would indicate settlement I suppose.

I have tried to work out some parallel between the climatic conditions there and our own country; I am not able to give it to you exactly, but I am obtaining exact data from the British Ambassador at St. Petersburg which I hope to have in a few weeks. I think that the figures given by the Russian Government would probably be the most favorable that they could furnish. The mean temperature for the period from Sept. 1st to June 1st, which would include the winter months,—I think that is all it is necessary to discuss—would, for the Province of Tobolsk, be practically about the same as in our North country. It is a very striking thing that a million and a half of people live in that province and that they raised 6,480,000 bushels of wheat in 1900. Surely if our country is as good as we think it is we ought to people it to as great and even a greater extent, and to complete the parallel between the two, I think I can say without any hesitation that we have something which they have not got, and that is the benefit of British institutions.

When I was discussing the wheat question in connection with these points that are colored red on this map, I drew attention to the fact that they were not selected for wheat raising. I want to discuss that point a little further. There are three reasons why we can expect better results in wheat raising in our northern country than has been accomplished up to the present time. I will quote what Professor Macoun has stated in a pamphlet relating to the Yukon (reads):

"When grain ripens in the country and is again sown there, it will take on the conditions of its environment and mature earlier, and early frosts, like those attributed to Manitoba, will have no effect, as the crop will mature before they come. I may remark here that the wheat in the Northwest ripens earlier now than it did twenty years ago, and many people believe that it is the climate that has changed, whereas it is only the wheat that has adapted itself to its environment."

I think that any gentleman who has been following the trend of affairs in the Northwest will agree with me that the conditions are better with respect to possible injury by summer frosts now than they were twenty years ago. I don't think that can be questioned. That is one reason that is given. Now I asked a gentleman prominent in the grain trade in the West, and who is better able to express an opinion on the point than I am, a few days ago, what he thought of that statement of Professor Macoun's. He said: "I don't altogether agree with that statement. I do not hesitate at all in saying that the improvement is marked, but I will account for it in another way. If you raise wheat on virgin soil on the prairie it will grow to perhaps the height of a man's shoulder the first year. The next year it will not be quite so high. The third year it will be perhaps not so high as the second year, but it will mature earlier.

Devote that land to some other use for a year or two and then go back to the cultivation of wheat again and you will get the wheat growing to the height of about the second or third year, but it will mature earlier. The soil is sharpened." He explained to me that in the Red River Valley, where the land is heavier, it would take very many years to bring about that result, and it would not be of so much value to this generation; but in the lighter soil farther west it has a marked effect, and as he argued, there is no question about it.

The third reason why we can expect better results in that north country is because the staff at the Experimental Farm, Ottawa, have been steadily carrying on experiments with a view to obtaining a variety of wheat that will ripen a few days earlier: and if they can shorten the term for the ripening of wheat by four or five days or a week, it will bring into the certain line as to wheat growing a very large area of land. They have accomplished some good things already, and they expect to accomplish a great deal more.

There is no question about it that in the north country there are grasses of the greatest possible value to cattle raising, finer grasses than there are in other parts of the Northwest. I could read from a letter written by Professor Macoun on that point. I do not like to pass Professor Macoun's name without saying that I believe that if there is a man whose name will be handed to posterity in Canada with honor it is that of Professor John Macoun, because of the optimism he has always had with regard to that country from the first.

Perhaps I might relate to you a little incident that happened to me in the spring of 1882. I was down at Warren's Landing, at the foot of Lake Winnipeg, about the 1st June, 1882. It was an isolated place to some extent, and rather difficult to get at, and our arrival in June on the first steamer was the first intimation they had there of a great many things which had been happening about the boom at Winnipeg. I was talking with a gentleman there who was connected with the fur trade and had been in it nearly all his life. He was a man of intelligence and was able to talk intelligently about any subject which you might mention, and he was perfectly sane except on one point. I was telling him about all the things that were happening at Winnipeg, and among others the fact that the Canadian Pacific Railway had built enormous shops. He then said: "It doesn't make any difference, Mr. Young, they will be allowed to fall to pieces. That country is no good, it is only good for the fur trade. I have lived nearly all my life in this country, and we old-timers know much better about the country than anyone else." "But," I said, "they are spending millions of dollars in building a line across the prairie." He said, "I don't care, you will find they will take up the tracks." That man was able to talk sensibly about anything else, but there you see was the influence of the fur trade, the influence of the conditions that he was surrounded by; and you will find that time after time when gentlemen in that northern country who had been connected with the fur trade are asked about the country their inclination is always to detract from its value. We hear a lot about the "Last West," our great west, and its value for settlement. I suppose that it is the Last West and I suppose that it is the last, not only for the fur trade of the Hudson Bay Company, but also for other people who are interested in that trade. They are not enthusiastic about encouraging settlement.

There is another point that I want to bring to your attention as to the conditions in the Northwest country. About three weeks ago I wrote to Professor Macoun and gave him a list of questions about that country, to which I asked him to give me answers. I think it is a very remarkable thing that in his reply he says: "In my report to Mr. Alexander Mackenzie, in 1877, just when I was fresh in the Northwest, I gave details about certain districts of the Northland which I could not give in a letter, but I would suggest that extracts from this report may be taken and placed upon file with this letter, as my statements and conclusions as printed thirty years ago still remain without impeachment at the present time." I think it is a remarkable thing that with respect to the country through which Professor Macoun went in 1872 and 1873, and which excited his enthusiasm —this is the country that I am trying to tell you about—he now says of it, "My statements remain without impeachment at the present time." Now he speaks in this letter of two facts that I think are very striking. He says: "In conclusion, I may say that the climate of the whole Northland is a stable one, and as local conditions change it will improve, and where small spots are now called good land, whole areas will take that term. The low altitude and the long day are fixed conditions and will always be the same. The forests will be cleared and the muskegs drained, and as the land becomes drier the frosty conditions will pass away and a great country will result."

Now there are some other sources of wealth in that country. I am going to place this pointer on the pencil line that I have drawn on the map, extending from about the middle of Reindeer Island in Lake Winnipeg northwesterly and crossing the Peace River about fifty miles north of Peace River Landing. That is the line shown on a Departmental publication issued a year or so ago, the mineral map of Canada, as the northerly limit of prospecting. North of that line there is practically no prospecting, as the note on the map says. The mineral wealth of that country is very great. There is no question about it, but that there are a great variety of minerals. The first thing I want to touch on is petroleum. That has been frequently spoken of as the petroleum field of the world, and I will just give you one point about that. Mr. McConnell made an examination of that field some years ago for the Geological Survey, and he made a calculation of the amount of crude petroleum which it would have taken to have saturated the ground to the extent that he had discovered. He says that the amount of crude petroleum sufficient to saturate the area that he had examined would be 6½ cubic miles. A witness before the Senate Committee in 1888, whom I quoted a few minutes ago, Ex-Judge McLeod, said that there was an area of 100,000 square miles in that country within which there were found indications of petroleum. There is a tar spring down at Great Slave Lake, there are some, I think, on the Mackenzie, and there are 75 miles, or thereabouts, along the Athabaska where these tar springs are found, caused by the oozing out of petroleum through centuries of time. I have a photograph here that I can show you of a bank of the Athabaska river, somewhere near Fort McMurray, and I think from the height of the man standing on the bank that it would be about two hundred feet high. It has been represented to me as being solid tar or asphaltum. At any rate, the soil is saturated with petroleum to the whole depth of the bank.

Now as to natural gas. It is a matter well known to many people that there is natural gas in that country. There was a well sunk twelve years ago on the Athabaska, and it has been burning ever since. It is spoken of as the largest gas well in the world. You will find that a great many travellers who have gone through that country lit natural gas along the banks of the river and used it for camp purposes. A gentleman who was there boring for oil told me that he had used natural gas constantly, as it was escaping through natural openings in the ground.

Then there is salt. Let me quote again from the evidence given before the Senate Committee: "Near Fort Smith there is a salt mine which is probably the most beautiful and the most abundant in the universe. There is here a veritable mountain of salt. By digging a little in the earth, from six inches to a foot, rock salt can be found there."

Gold has also been discovered there; also copper. There is no question but that copper exists at some points in the Barren Lands. Bishop Clut, in his evidence before the Senate Committee, spoke of Indians coming into Fort Providence and having crosses made of copper. I do not think that any white man has found out exactly where that copper came from. At any rate, there is lots of copper.

There is also coal. In 1789, when Sir Alexander Mackenzie went down the Mackenzie river, he found that there was coal in the banks which was burning, and this extended for many miles along the river. That coal is burning yet.

Iron also exists in many parts of that country. Mr. Tyrrell, I think it was, described the country north of Lake Athabaska as being most promising from a mineral point of view. I cannot enlarge upon the subject of minerals, but I merely mention the fact of their existence.

I want to ask your attention for a minute or two upon a point about the mineral question in that country which has impressed me, but I do not know whether I can convey that impression or not. I want you to consider Dawson City, which is marked with a small red star on the map. I have here a clipping from the 'Manitoba Free Press' of twenty years ago, in which it says that miners had just discovered gold in the northwestern part of Canada up near Alaska. That was the first intimation that any gold was to be found there. I have the figures of the Geological Survey showing that over $123,000,000 of gold were taken out from the Klondike fields up to January 1st last, and it is well known that that amount is far within the mark. As a matter of fact, the output is a great deal more than that. So much for Dawson City.

Take Rossland, B. C. I lived in that city for two years, and I am somewhat familiar with the conditions. The townsite of Rossland was ungranted land of the Crown in the year 1894. The Le Roi mine is just on the edge of the townsite, and the total product of gold, silver and copper at Rossland up to the same date as I have given for Dawson was over $40,000,000.

Now just for a moment let me refer to Fernie, B. C. The coal deposits at Fernie were unknown twenty-five or thirty years ago, while to-day the coke required for smelting operations throughout the interior of British Columbia is furnished from Fernie. When I was in that country in 1896, they were importing coke for this purpose from Swansea in Wales. I got some figures from Dr. Haanel, Director of Mines, about the coal at Fernie, and from the figures which he gave me I make this calculation: there were 1,800,000 tons of coal mined in the year 1907. Taking that as a basis, it will take 12,222 years to exhaust the coal in that field at that annual production per year.

Another point farther east, in our own Province of Ontario, is Sudbury; the discovery of the copper and nickel mines of Sudbury was coincident with the construction of the Canadian Pacific Railway, and the discovery of Cobalt, is a matter of about five or six years. Now I think that when you reflect upon the fact that these discoveries have been made in a partially prospected portion of Canada, but only partially prospected, and consider that probably more than one-third of the total area of the Dominion has not been prospected at all, and that these discoveries have all been within the last twenty years, you will admit that it opens up great possibilities. We have the evidence from the staff of the Geological Survey as to the discoveries of the past, and there is every reason to expect that there will be equally great mineral discoveries in the Northwest in the future.

The timber resources of the country I have not got time to dilate upon, but they are known to be very great.

I just want to mention the water powers. There are beyond question water powers of enormous value in that country, and with the development of electricity it is hard to set a limit on the value which those water powers may have.

I am going to mention one more subject, and that is the fish wealth of the North. If there was no other source of wealth in that country I think it would be of tremendous importance to the people of Canada to be made aware of the value of the fisheries of that country. There are in every lake, river and stream enormous quantities of fish: whitefish, lake trout and jack fish in the clear waters, and sturgeon in many rivers, salmon in the rivers running into Hudson Bay and the Arctic Ocean, and the salmon known as the Inconnu in the Mackenzie river and in Great Slave Lake.

I have tried to compile figures that would impress upon you the value of the fisheries, but I do not know whether I have accomplished anything or not. With such meagre information as I had, I tried to make an estimate of the water area in that country. Every lake, river and stream probably is full of fish. West of the Nelson river and north of the settled area, I estimate there are about 75,000 square miles of water. There is a great deal more than that, because there are many smaller lakes that we have not got any information at all about. That is very nearly the same area as there is in Lakes Superior, Erie and Huron combined, but the Canadian portions of all the Great Lakes would not exceed about 33,000 square miles. There are two lakes, Great Slave Lake and Great Bear Lake, each of which is larger than Lake Erie, considerably larger.

The natural system of waterways in that country attracts one's attention. I have not got the figures exactly at hand, but I think it is in the neighborhood of 1,300 miles from Fort Smith to the mouth of the Mackenzie river, in which steamers drawing six feet can navigate at any time of the year when the river is open. Fourteen miles above Fort Smith you get into another system of waterways going up the Slave and up the Peace rivers, with falls not far from Vermilion. Above those falls you can go for 550 miles up the Peace river to the Rocky mountains, all navigable. Then there is the Athabaska river, or a considerable portion of it. So we have very much over 2,000 miles of navigable waterways in that country.

Now, gentlemen, there is a deduction that seems to follow from all these statements if they amount to anything at all. That deduction is, that it is time that we knew more about the country. I think it is time more knowledge was acquired, and I am going to ask you to consider for a few moments a condition somewhat similar to that which we have here in another part of Canada—I refer to New Ontario. Previous to about the year 1899, I think, it would be the opinion of anybody who knows anything of Ontario that the region north of the Canadian Pacific Railway line was of no value whatever for any purpose practically speaking. I had always heard it so spoken of myself, but without dwelling upon it, let me say that it was a country which did not promise to be ever of any great value. Some six or eight years ago an exploration of that country was undertaken. I believe that for departmental purposes New Ontario was considered to be the country lying north of the main line of the Canadian Pacific Railway. The country was divided into ten districts, and there were surveyors appointed who took charge of each district for exploration purposes. Attached to each party was a land examiner, a geologist and a timber expert. Well, I have been told—I went to some trouble to find out—that the cost of that exploration was $74,000. When the reports of these exploring parties were made up the Government were able to announce that there were 16,000,000 acres of clay lands in New Ontario suitable for settlement. There were nearly 300,000,000 cords of pulp wood discovered in New Ontario. Was not the building of the Temiskaming and Northern Railway a result of that exploration? The discovery of Cobalt was in consequence of the construction of that railway; and I believe the fact of there being 16,000,000 acres of clay land in New Ontario, which will be traversed from end to end by the Grand Trunk Pacific Railway, was an assurance to the people of Canada that there would be local traffic on the line and it would, therefore, be a much more certain enterprise than it otherwise would have been.

There have been 1,800,000 acres of land surveyed since that exploration took place as a result of it, and the Deputy Commissioner in Toronto in writing to me made a very remarkable statement. He said that in some of the townships it had been found that there was not one single acre of land which was not suitable for settlement, and, he added, " I think that is a record unique in any country."

Now I have just about finished, gentlemen, and I hope I am not wearying you. I told you at the outset that there were practically 7,000 miles of railway. There are the Canadian Northern, the Canadian Pacific and the Grand Trunk Pacific systems, and you will notice on the map not far west of Winnipeg three small lines, which represent the Hill lines, which have just entered into that country. I think there is no question that Mr. J. J. Hill would not undertake to enter that country to such an extent if he did not intend to remain there. Therefore, it is almost certain that the Hill system will spread over that country as well as the three other systems referred to. Now if you consider the railway situation there and bear in mind the facts which I gave a few minutes ago as to the result of exploration in New Ontario, have we not the right to expect if we can demonstrate beyond question by actual exploration that the north country is what I take it to be, that those railway systems will extend into it and occupy and possess it in the railway sense of the term? The Canadian Northern is at the Pas on the Saskatchewan, at Prince Albert, at Battleford, and at Edmonton. The Canadian Pacific Railway is at Edmonton. Surely the Grand Trunk Pacific Railway and Mr. Hill's system would not stop short of it if there was any traffic to be got. I think it is easily capable of demonstration that before long we shall see railway construction in that country which will open it up and lead to further discoveries.

I remember when we used to hear in the West, it was an expression used derisively about us from across the line and was used very frequently, that the Canadian Pacific Railway was "The Dominion on wheels," and it was often said that Canada consisted only of a fringe of settlement along the northern boundary of the United States. Well, gentlemen, when we consider that Fort Simpson is 900 miles north of the International boundary and that wheat has been successfully grown there under unfavorable conditions, I think that we are in a position to show that the Dominion has broadened considerably from what it was twenty years ago."

Mr. Young, in closing, pointed out how much it meant to the members of the Engineering Society of Toronto University and to the profession of Engineering in Canada that the development of the natural resources of this country of ours was up to the present time so small in comparison with the reasonable certainty of the future, and as a final word appealed to the young men of the Society to consider well if in any country there was a more magnificent heritage than is the possession of the Canadian people. He urged them also to remember always that such unequalled opportunities laid upon the people of Canada a tremendous burden of responsibility that they should adequately carry out to its fulfilment the magnificent destiny which appeared to have been marked out for them.

SHOULD FEDERAL AID BE GRANTED TO ASSIST TECHNICAL EDUCATION?

W. PACKENHAM, B.A.

Dean, Faculty of Education.

The modern world needs technical education. "To make well and to sell cheap" is the working creed of the great nations. "To make well" means more to-day than it meant a hundred years ago. Knowledge has put the forces of nature into subjection. Science, mathematics, and art have transformed all industrial activities. They have made old trades more exact and scientific, as witness the trades of the wood worker, metal worker, textile worker, and engineer. They have created new high-grade trades—the trades of the art worker, chemist, electrician, and that vast army of tradesmen who minister to the comforts of our homes and leisure hours. While the trades demand more knowledge, the shop tends to teach less. The old apprenticeship system is disappearing. The machine replaces the man. All work becomes standardized and automatic. The workman, limited in functions and mechanical in attainments, quickly attains his full industrial stature and as quickly degenerates. Over every phase of modern industry is written large the demand "more knowledge" and side by side with it appears the response "less opportunity." Here lies the need of technical education.

What is the world's need is in a special sense Canada's need, and what is the need of the man at the bench or counter is in a special sense the need of the captain of industry or the consulting engineer. Canada's raw materials are widely distributed and difficult of access. Her motive power is unlimited, but remote from urban centres. Her problems of transportation are greater than those ever yet solved by six million people. And she is exposed to the competition of the greatest industrial nation of modern times. Here lies Canada's special need of the highly-trained expert.

But technical education is expensive. No two nations and no two educationists agree as to its form and content: it is still in the realm of experiment. Experiments are proverbially expensive. They consume material under conditions that are not commercial. They have to do with hordes of students whose fee-paying powers are limited, and with teaching plants as varied as the trades, and as unstable as machine shops.

Who will bear the expense ? In Europe the burden rests with varying stress upon the trade guilds, the manufacturers, the municipalities, and the State. Everywhere the State's proportion of the burden steadily appreciates. In America next to the municipalities and the State, the philanthropists are the fairy god-mothers of technical education. Here, too, the State assumes a steadily increasing proportion of the cost of maintenance.

It would be far from generous to belittle the splendid benefactions of such men as Sir William McDonald, but Canada's needs in this matter of technical education cannot be met by her philanthropists. Nor should the municipalities be expected to meet them. These needs are national, not local. In any case, the burden would be too great for the municipalities. It remains, then, for the State to take up the burden.

Now the State may mean the Province or the Dominion. The Province, let it be confessed, cannot do much. Its revenues are limited, and they are strained to the breaking point by recent subventions to elementary education and to instruction in agriculture. The Dominion, on the other hand, has buoyant revenues collected from the people of all the Provinces. It has a splendid asset in crown lands purchased at the expense of all the Provinces. Finally, it has a dominant interest in such national issues as commerce and industry.

But the Dominion has been cautious, not unreasonably cautious, perhaps, in recognizing its duty in these premises. Education, it has pointed out, is, in the term of the B.N.A. Act, a Provincial, not a Dominion interest. It is unwise to disturb the Constitution. Interferences with Provincial rights have not been happy in results. Federal aid to Education in one form would be a grave precedent as regards all other forms. And so the Federal publicist has been cautious !

Let us look at this caution from the other side. The United States government aids technical education in the various States, and does not find it difficult to separate one form of education from another. The Dominion government itself aids certain forms of technical education in the Provinces, and has not found grave difficulties in the precedent. Grants in aid of technical instruction would not be unhappy interferences with Provincial rights when all Provinces and all classes in all Provinces welcome those grants. Moreover, grants-in-aid need not involve interference with Provincial control. They do not involve interference with State control in the United States, or with Cantonal control in Switzerland. The Constitution should be sacred, but it must change with the centuries. Canada's Constitution has already been changed for interests scarcely as important as technical education.

But would Federal aid to technical education be a violation to the British North America Act and would it require a change in that Act ?

In the terms of the B. N. A. Act trade and industry are Federal interests. Technical instruction belongs to trade and industry. Is it not therefore a Federal interest? The Dominion maintains a splendid type of instruction in engineering in the Military College at Kingston and defends such technical instruction as attaching naturally to militia and defence, which is a Federal interest in the terms of the Constitution. It maintains experimental farms, dairy stations, and cold storage centres, with bulletins to instruct the people in the operations of these agencies, and defends this technical instruction as attaching naturally to agriculture, which in its larger phases is a Federal interest in the terms of the Constitution. It goes even further. In commercial agencies in the world's great trade centres, and in national expositions and world expositions, it aids or organizes magnificent agencies in the development of industrial intelligence —a form of technical education which attaches logically to trade and industry, and is a Federal interest. Surely it would not be altogether unnatural, or illogical, or illegal, to recognize all instruction in the arts and crafts as within the sphere of trade and industry, and to that extent a Federal interest.

Even if technical instruction were a thing apart, attaching itself to education proper and not to trade and industry, the Federal government could still aid it and be consistent with its own practices. It assists the Canadian Mining Institute, the Royal Society, the National Art Gallery, and the National Museum. It maintains several biological stations, schools of navigation on the inland lakes, and to some extent, the Department of Railway Engineering of McGill University. It organizes a Bureau of Standards, instructs the commercial classes in the metric system, and experiments in the electric treatment of Canadian ores. Through its grants to the Royal Canadian Academy it aids the art schools of the provinces. Would it be wholly inconsistent to subsidize the science and art of the technical schools?

Federal grants to technical education would find precedents in the practices of other lands. The authority of the Federal government in Germany is singularly circumscribed. The German states are practically autonomous and jealously so. Education attaches to each state. And yet out of its large ambitions for commercial supremacy the Federal government maintains an Imperial Physical and Technical Institute for standardization and research in the industries, and organizes navigation schools, shipbuilding schools and schools of naval engineering on the Baltic.

Decentralization of authority is the keynote of the Swiss Constitution. Differences in race, language, and creed have secured permanence for that keynote. In the terms of the Constitution education is transferred formally to the Cantonal governments and the Cantons are peculiarly sensitive as to the maintenance of their prerogatives. But they welcome Federal interest in industrial education, and Federal grants in aid of the trade and industry of the country. Thus it comes about that the Federal government maintains at Zurich one of the world's foremost colleges of Technology. It subsidizes the higher commercial colleges of the Cantons, and even many of the primary commercial schools. Quite recently, indeed, it has organized a schedule of grants for agricultural and industrial education of an elementary type, for schools of domestic economy, and for schools for the professional training of women.

But more interesting to us and more pertinent is the precedent set by the United States. State rights mean more to the average American than provincial rights mean to us. Education is a state right, and yet in the Morrill Act of 1862 the United States Congress granted the equivalent of 13,000,000 acres of land, valued at $10,000,000, to the various states in aid of state colleges for instruction in agriculture and the mechanical arts. In the Morrill Act of 1890 Congress added to this an annual grant to each state of $15,000 (which increased to $25,000 in ten years). Going even further, Congress makes a special annual grant to each state of $15,000 in behalf of an experimental and scientific station in agriculture. From all sources the Federal grant to the states in behalf of technical education now amounts to 41 per cent. of the total revenues of the technical colleges of the United States. In the presence of such examples need the Dominion hesitate?

Finally, above and beyond all statutes and precedents stands the great truth that the Federal government is sponsor for the commercial and industrial welfare of this country. In the performance of its duties in this regard it arbitrates trade disputes, organizes trade agencies, negotiates commercial treaties or establishes national tariffs. But arbitrations, agencies, treaties, and tariffs are altogether vain things if the Canadian workman or the Canadian engineer lacks industrial intelligence. To give industrial intelligence then is here the first and great duty of the Federal government. Can it perform this duty without cost?

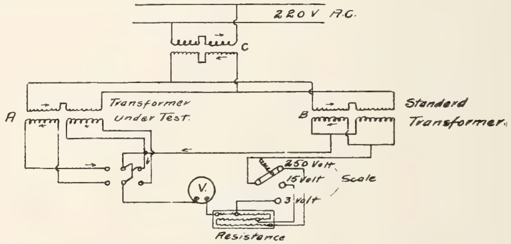
SOME NOTES ON TRANSFORMER TESTING.

E. M. WOOD, '06

It is not the intention of the writer to try to write a treatise on the subject of Transformer Testing, but to offer a few practical notes based on experience on certain methods, which do not come within the scope of the instruction given in the School.

The purpose of commercial testing is twofold: first to make sure that the construction of the piece of apparatus is mechanically and electrically correct, and secondly to give the engineering department data to check the correctness of their designs, constants, etc. Tests made for the latter purpose are usually omitted on apparatus that is "standard", that is on apparatus of which a considerable number of units have been built to the same specifications. The first few machines built under new specifications should have complete tests.

The first class of transformers whose testing we will discuss is the small "lighting" transformer, usually of less than 100 k.w. capacity. Since these are turned out in comparatively large numbers in standard sizes, voltages, etc., it is essential that the tests on these should be sufficient and, at the same time, not take too much time. The standard tests are for insulation, polarity, conversion or voltage ratio, losses, regulation and heating. The insulation tests are of two sorts: the high voltage test to detect grounds, and the short circuit test. This latter test consists in applying double or triple normal voltage to the secondary winding of the transformer. This gives double or triple the normal voltage between turns in the winding and causes a short circuit and burn out if the insulation between turns is weak. To avoid large exciting currents the highest available frequency is used. (In all testing departments the low-tension side is called the "secondary" and the high tension side the "primary").



The conversion and polarity tests check the proper winding and assembly of the coils. A rather neat scheme for taking polarity and conversion at once on a transformer of standard voltages is shown in Fig. 1.

The transformer under test A and a transformer B of the same voltages and ratio, whose ratio has been carefully taken by voltmeters, are connected in parallel on the primary side, and both excited from a suitable transformer C as shown. Then each secondary coil of A is connected in turn, as shown, in series with the standard secondary and a voltmeter, so that if the polarity is right, the units of the two coils oppose each other. If conversion and polarity are right there will be no voltmeter reading. The voltmeter should be provided with taps in its resistance so as to give, for example, 250, 15, and 3 volt scales. The 3 volt scale is necessary to show whether or not the conversion is exactly correct, but when first connected the voltmeter switch should be on the 250 volt connection (i.e., if the transformers have about the standard 110 volt secondary coils), so that the meter will not be damaged if the polarity happens to be wrong. Of course a wrong polarity on a coil will show by adding the units instead of substracting, and the meter will read 220 instead of zero.

Core losses and copper losses are taken by wattmeter by well-known methods. Frequency should be correct and the wave shape of impressed voltage sinnsoidal, or else the wave shape and the relative core losses due to this shape and to the sinnsoidal wave, should be known. Since the readings on the wattmeter are small, the meters should be connected so that each meter reads exactly what it is intended to read; errors due to power taken by other meters being generally not negligible. Proper connections are shown in Figs. 2 and 3.

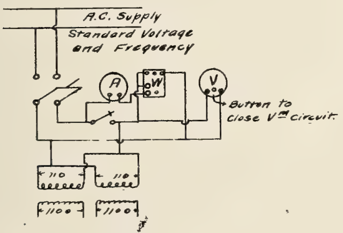


Figure 2— Core Loss Connections.

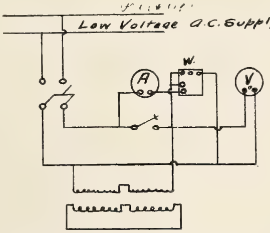


Figure 3. — Impedance Connections.

For core loss, the voltage should be set, then the voltmeter circuit opened and watts read, then wattmeter pressure circuit opened and exciting current read. In the impedance copper loss test, the current is set with all pressure coils open, then impedance volts and then copper loss watts read separately. All current coils should be protected by short circuiting switches. This is a precaution that should be taken in all testing work.

The heating test usually consists in running the transformers in pairs under core loss and a small overload copper loss for a couple of hours. The method will be considered in detail later. This test is merely a load run to show up weak spots. The tests for heating are made when the type is under development, and not necessary on the article after it has become standard.

Practically the same tests are applied to large power transformers. However, as these are not so well standardized as the smaller types, special methods have to be employed.

Conversion is best taken after the core has been built up, but before the transformer has been completely assembled, because with the large "slab" wound transformers with many coils it is easy to get coils interchanged, or wrong way around, and the transformer has to be torn down. The best procedure in taking conversion is to first make out from the winding specifications a diagrammatic scheme of the windings, showing the number of turns, the location of taps, ends of coils, etc. Then a suitable number of turns in a coil is taken as a primary, a voltage of so many (say 2 or 10 or whatever is convenient) volts per turn is impressed and voltages on the other sections read. The volts per turn for each section should be the same. The laying out of the scheme for taking conversion requires some ingenuity and a knowledge of the meters, potential transformers, etc., available. Voltmeters for this purpose should be kept carefully calibrated.

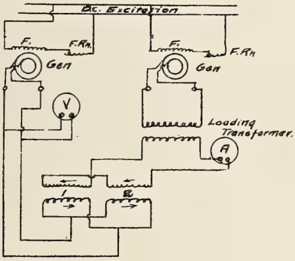
Core loss is taken in much the same way as in case of small transformers. The method or order of connecting the meters in circuit is scarcely so important as meter losses are negligible. Wave form of impressed voltage is as important as before, if comparison between different transformers is desired. It is customary in some places to take an oscillogram of applied voltage under some standard conditions, for example, normal voltage on transformer. This is filed with the test report for reference.

Any available part of the winding with sufficient number of turns to keep within reasonable limits the magnetizing current necessary to produce the normal voltage core flux, may be used as an exciting coil, and to it should be applied its proportion of the normal working voltage. This will produce normal working flux in the core and normal core loss. The coil should be so chosen, if possible, that its voltage is less than 3,000 volts, as below that voltage it is safe to use resistance multipliers in the pressure circuit of the wattmeter. These are more satisfactory than the potential transformer, as the latter does not have its primary and secondary voltages in exact opposition in phase. This causes the wattmeter to read too low.

Copper loss and short circuit impedance volts are taken by the usual short circuit test. Resistance of primary and secondary windings with connections for the short circuit test should be found, and the connected and observed total copper loss should check very closely.

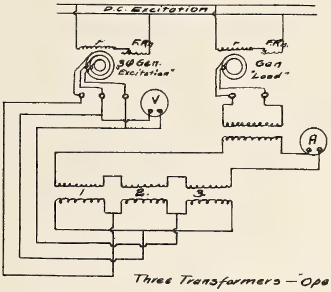
Resistance may be taken by D.C. drop of potential method, or by Wheatstone Bridge. In taking resistance by bridge, it is advisable to keep the "battery key" closed until the reading is completed, to avoid the great self-inductive "kick" when it is opened. Incidentally, this necessitates the use of a good battery in connection with the bridge. For the P. D. method a storage battery or D.C. exciter may be used, with suitable rhostats in series. The cores of large transformers seem to possess considerable magnetic inertia, so in order to avoid disturbances and variations of the voltmeter readings, as the magnetism in the core is gradually built up by the effect of the direct current in the windings, it is well to apply current up to about twice the value it is intended to use, hold at that value about a minute, then reduce the current to the required value, and close the voltmeter circuit. If the voltmeter needle is steady and does not "creep" towards lower readings, the meter readings may be taken. In order to damp out variations in D.C. current, the winding that is not having its resistance measured may be short circuited on itself. Connections for voltmeter should be made nearer the winding than the connection points of current leads and transformer leads. This arrangement insures against including the contact resistance of the leads in the resistance of the transformer coil.

Heating tests on power transformers are necessarily made with more care than on lighting types. The iron and copper losses are supplied as follows: The transformers are connected as shown in the diagrams 4 and 5, "bucking" if two of a kind are available, and "open delta" on the primary side if three are under test.



Two Transformers — "Bucking."

Figure 4. Heating Test Connections



Three Transformers — "Open Δ

Figure 5. — Heating Test Connections

Take the case where two are under test. The core losses are supplied by exciting the two secondaries in parallel, up to normal working voltage, by a suitable generator, with or without an auxiliary transformer. The impressed voltage is adjusted by varying the field of the generator. The secondaries should be connected so that all their windings are in circuit. The primaries are connected in series, as shown in the diagram No. 4. This causes the primary E.M.F.'s to be opposing each other or "bucking," and the voltage across the two is zero. If an A.C. voltage at any convenient frequency be applied here equal to the sum of the "impedance" voltages of the two transformers at that frequency, full load amperes will be forced through primary and secondary windings of both transformers, for, as will be seen by the diagram, the secondary connections form a short circuited secondary to this primary "impedance" voltage, as in the impedance test. This current then supplies the copper loss, and does not unbalance the core loss seriously. This "load" current may be supplied by a separate generator or by the "exciting" generator, but should pass through a transformer with strong insulation between primary and secondary, even if the required ratio of transformation is 1 to 1. This is necessary because the "load" wiring may have a potential against ground equal to the high tension voltage of the transformer under test, and it is easier to insulate against this in a transformer than in a generator. If three transformers are to be tested they are connected as shown in Fig. 5. The secondaries are excited in $\triangle$ from a three-phase generator and the primaries are connected in open delta as indicated, and the load current introduced into the open "corner."

Resistances and temperature should be taken before starting the heat test. The transformers may be put on overload copper loss until the oil temperature shows that heating is about to final value, then the losses are set at normal value and the cooling medium (usually water) introduced, and the amount adjusted according to guarantees. When it is reasonably certain that this is correct a resistance may be taken, and the conditions maintained another hour or so, followed by a final hot resistance. This should be the same as the last one. For calculating temperature rise by resistance, it is best to base calculations on change of primary resistance. "Hot" resistances should, if possible, be taken with same meters and same current settings as the "cold" resistances.

Short approximate formulae are in use for calculation of temperature rise by resistance. One of these in use is as follows:

$$\text{Rise by Res. in } C^\circ = \frac{\text{Res. hot} - \text{Res. cold}}{.0041 \times \text{Res. cold}}$$

After a transformer has slightly cooled down from the heating test, it should be given the "high voltage" ground test. This consists in applying from two to three times normal working voltage between primary and grounded (to case and core) secondary, and between secondary and grounded primary.

The testing transformer should be excited from a generator of suitable voltage, so that the generator voltage will be somewhere near its normal value when the high tension testing voltage is correct. This allows the generator to give its proper wave form. This should be as nearly as possible a sine wave. The voltage should be adjusted by means of the generator field rheostats, and never by rheostats in series with the low tension side of the testing transformer, as their presence there changes the wave shape. Testing voltages may be measured by spark gap, by conversion, or by a combination of the two. If the transformer under test be insulated from ground by being set on an insulating platform, the middle point of the testing transformer's high tension winding may be grounded. A section of this winding next to the ground may safely have a tap brought out, suitable for voltmeter readings, containing say $\frac{1}{1000}$ of the high tension turns between the tap and the ground. This gives a measure of the high tension voltage. The voltmeter readings should be checked by spark gap under *actual conditions* of test.

The procedure in applying high voltage test to a large transformer, then, is as follows: The testing transformer is connected to the transformer under test, one terminal to primary winding, the other to secondary winding and case. Across these leads is connected the needle gap. Often to keep down current surging when the gap breaks, water resistances are connected in series with the spark gap. These reduce the effective spark gap length by an amount that must be found experimentally. If the testing voltage is, say, 100,000 volts or less, the gap is set at the required length according to A.I.E.E. curve, for fresh needle points. With transformer connected in circuit, the voltage is increased gradually by generator field control and the voltmeter reading carefully watched until the gap first snaps. Voltmeter reading before the "jump" is carefully noted, and the field lowered to zero. Then the gap is opened wide and the voltage gradually brought up till the same voltmeter reading is obtained, held one minute and gradually lowered to zero. It should take at least three minutes to bring voltage from zero to required testing voltage. Sudden changes of voltage should be strictly avoided. For voltage of over 100,000, the procedure is slightly different. The spark gap may be set at $\frac{2}{3}$ testing voltage. Carefully break down this gap, noting voltmeter reading. Having separated the needles, bring up the voltage to $\frac{3}{2}$ the former reading, corrected for calibration of the meter.

After a transformer has stood insulation test it should be run under normal voltage for a sufficient time to make it evident that it has suffered no damage from the test.

MODERN FINE GRINDING MACHINERY

E. V. NEELANDS, '00

The most essential feature in the successful treatment of ores amenable to concentration, is that a stage of crushing shall be reached at which the particles of valuable mineral are free from the associated gangue, in order to allow the millman to take full advantage of any distinguishing feature of either to effect the desired separation. Whatever be the preliminary process, excepting a few special cases, the resulting pulp must be reduced to a very fine slime to fill this condition. That this fact has been fully realized is evinced by innumerable patents for fine grinding machinery, much of which is now in more or less successful operation. Prominent among these are Chili & Huntington mills, stamps and narrow-faced, high speed rolls, but all open to many objections when grinding finer than to 40 mesh, at which size the tailings from most plants would contain values which could not be recovered.

These objections may be briefly summed up: In the case of Chili & Huntington mills the wear is very great, the renewals costly and much attention is required. In this connection the great importance of selecting mill machinery which practically cannot get out of order, is to be emphasized, because the modern mill is a continuous series of machines, each adjusted to take a definite product from the one preceding, with the result that the failure of even a minor part may cause many hours' delay. Rolls are open to the same objections, their adjustment for fine crushing being very difficult to maintain, in addition to the fact that the product must be continually returned in order to reduce to any definite mesh. Stamps while very efficacious for many kinds of work, are inefficient when reducing to slimes, the same blow being delivered and the same power consumed in crushing 2-inch cubes as in reducing ¼-inch material. The wearing surface of both dies and shoes is always sufficiently uneven to allow the escape of the greater part of the partially crushed ore and to throw the whole force of the blow on a comparatively small percentage of it, reducing much material to the impalpable slimes so difficult to handle by the ordinary gravity methods.

The increasing demand for an efficient machine for this work eventually produced the tube mill, which consists of a sheet-iron drum with cast steel ends. It is lined throughout with hard steel liners or cut flint bricks set with neat cement and contains one or more tons of flint pebbles. The drum is rotated by means of a pulley and shaft and tooth-wheeled gearing and in the common forms is supported at each end by hollow trunions which serve as bearings as well as passages for a continuous flow of feed and product. The ore, crushed to from 8 to 20 mesh, enters the mill by a suitable contrivance, is triturated by the pebbles in contact with each other and the lining and as it becomes sufficiently reduced to be held in suspension by the agitation of the water, flows through a grating, from the discharge end.

The speed of rotation has been a matter of some discussion, but the best practice, especially on the coarser grades of feed is that the speed should be slightly lower than that at which the mass of pebbles would be carried completely around the drum by centrifugal action. The pebbles should rise to a point about one foot lower than the top of the drum and then drop violently. This action may be observed in some machines by removing the hood on the discharge end and holding an incandescent lamp in the hollow trunion. In a mill 6 feet in diameter, it takes place at 21 R.P.M. in the absence of water; if water is used at 27 R.P.M. The peculiar feed and discharge arrangement of the Abbe tube mill have resulted in a very different conclusion by its manufacturers. These arrangements permit the mill to be used when practically filled with pebbles, the action being simply grinding without impact, but giving an enormous number of contacts per revolution. As will be readily observed, this limits the size of feed to a mesh at which comminution can occur by the mere friction of the pebbles. This mill is claimed to be efficient on 30 mesh material (*a*). The opinion of the writer is that the former practice is the better as it allows the product of rolls to be fed directly to the mill, eliminating any intermediate crushing. (See mesh tests, page 271.)

One of the most important features of the tube mill is that is it absolutely automatic and continuous. This great advantage over other forms of comminutors will be at once recognized by the practical millman. There are no nuts to get loose, no adjustments requiring shut-downs and no tires or dies to be trued up. In the mill under the writer's direction, the only costs for a year's operation have been for pebbles (two tons, original charge not included) and for lubrication. Linings have to be renewed in from four months to a year, but the recent introduction of automatic linings bids fair to largely eliminate this expense and loss of time. These linings are of various forms and depend on the tendency of pebbles to wedge themselves in any crevice. Ribs of iron are placed close together in the drum forming recesses into which the pebbles are driven by their own action (*b*).

These machines have found special favor on the Rand and are now used to a large extent in Mexico and the United States. In the majority of cases they are used for reducing the tailings from stamps for treatment by cyanide. At the present time there are sixty at work at Johannesburg alone (*a*). Opinions on the Rand varied for some time as to the question of their advantage

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(*a*) **Engineering and Mining Journal, advertisement.**

(*b*) **" " " Vol. 84, No. 21, page 986," Tube Mill Lining, H. W. Hardinge** over an improved form of the grinding pan (*b*), but the latest advices are in favor of the tube mill (*c*). The disadvantages are: (1) Heavy initial cost, especially in places not reached by railroad; (2) inaccessibility; and (3) inflexibility of the unit. The latter is the chief drawback; if one mill is slightly overloaded, it is necessary to provide another with the result that their combined capacity is greatly in excess of the work to be done while the power and other costs doubled. In a case where the product is to be treated on tables it is also very difficult to control the size of product, which in the case of a light feed, has a tendency to become an absolute slime. As the drum should be absolutely tight, access to the interior can only be had by means of a manhole cut in the shell; this hole must be firmly closed as a leakage may cause a serious loss in addition to a rapid destruction of the gearing if it is accessible to the pulp.

A consideration of the limitations of the tube mill resulted in the introduction (November, 1907) of an improved and modified form of pebble comminutor, the Hardinge Conical Mill. Except in a few minor details this machine differs from the tube mill in shape only, the drum or tube of the latter being replaced by a form, which may be described as a short cylinder, having each end rigidly attached to a cone. The apexes of the cones are hollow trunions, which act as bearings and as passages for the pulp as in the parent machine. (See cut front page Engineering and Mining Journal, Nov. 23, 1907.) A very good model of this mill may be made by taking two large glass laboratory funnels and attaching them together by means of electric tape. If this model is partially filled with small pebbles, ¾-inch diameter to 8 mesh, and slowly revolved in a horizontal position, the action of the mill can be seen and appreciated. After a few revolutions it will be seen that the larger pebbles have displaced the smaller and occupy solely the zone of the greatest speed at the junction of the two cones; the pebbles are perfectly sized in order of their weights, from the greatest at the centre, extending up the slope to the smallest towards the ends. This action as has been proved by actual practice takes place in the working machines.

The result of this action will be readily observed: The ore enters through the trunion and spreads out as it flows down the incline; the heavier particles find their way to the centre at once where they are subjected to the heavy blows of the large pebbles and as they are reduced, work up the opposite incline, still under the action of proportionately smaller pebbles, until they are sufficiently reduced to flow from the discharge end. This is apparently an ideal crushing arrangement, the ore particles arranging themselves so that each is subjected to a blow suited

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(*a*) Tube Mills on the Rand, Mining and Sc. Press, Jan. 4th, 1908.

(*b*) Denny on Gold Milling Equipment, Pro. Inst. Civil Eng. Vol. CLXVI, Nov., 1906.

(*c*) Progress on Treatment of Gold Ores, Alfred James, Mining and Sc. Press, Jan. 4th, 1908.

to its size, and passing when broken to lighter and more numerous blows, and when sufficient reduction has taken place, being at once removed from further grinding action.

This sizing action of the mill is under perfect control within wide limits by the use of an elevating gear, by which the discharge end is raised or lowered a few inches. If lowered the slope of the incline is lessened and the ore discharges in a less finely ground condition, with almost no slimes, and if raised it can be ground to practically any degree of fineness. In this way the mill can be made grind to a definite mesh, with a precision that cannot be approached by any other machine.

An important consideration is the saving in power of the conical over the drum form of mill. It will be at once noted that in the latter form the whole mass of pebbles is lifted practically the whole height of the machine, most of this work being unnecessary and reducing beyond the desired point, whereas in the former only part of the mass is raised fully to work on the coarse material and the remainder only partially to reduce the finer sizes.

By the introduction of balls or pebbles up to five or more inches in diameter for work on the coarse feed, it has been found possible to make this mill handle feed up to ½-inch mesh, a very great advantage over the tube mill, as the latter is practically limited to sizes smaller than 20 mesh and if fed with coarse sizes quickly "mucks up," owing to the fact that the small pebbles used cannot crack the ore particles and can only reduce them by attrition. (See mesh, page 272.)

Appended are the results of sizing tests on the various machines alluded to:

Abbe Tube Mill working on feed stamped through 20 mesh, 18 R.P.M. charged with 5 tons of pebbles:—

Feed.	
On 30 mesh ...	2.6 p.c.
" 40 " ...	4.4 "
" 60 " ...	14.8 "
" 80 " ...	18.2 "
" 100 " ...	15.6 "
Thro' 100 mesh.	41.2 "
	100.8

Product.	
On 60 mesh ...	4.2 p.c.
" 80 " ...	9.4 "
" 100 " ...	10.5 "
Thro' 100 mesh.	75.7 "
	99.8

Prosser Tube Mill working on ball mill product through 8 mesh, 26 R.P.M., charged with 2 tons pebbles, producing 2.5 tons per hour:—

Feed.		Product.	
On 10 mesh ...	5.7 p.c.	On 60 mesh ...	.6 p.c.
“ 20 “ ...	40.2 “	“ 80 “ ...	4.6 “
“ 40 “ ...	19.0 “	“ 100 “ ...	14.7 “
“ 60 “ ...	7.0 “	Thro’ 100 mesh.	79.8 “
“ 80 “ ...	6.2 “		
“ 100 “ ...	10.4 “		
Thro’ 100 mesh.	12.0 “		
	100.6		98.7

German Tube Mill working on feed stamped through 25 mesh, charged with 5.5 tons of pebbles, consuming 48 H.P. and producing 4 tons per hour:—

Feed.		Product.	
On 40 mesh ...	1.5 p.c.	On 60 mesh ...	.5 p.c.
“ 60 “ ...	13.5 “	“ 80 “ ...	1.5 “
“ 80 “ ...	17.0 “	“ 100 “ ...	2.0 “
“ 100 “ ...	17.5 “	Thro’ 100 mesh.	96.5 “
Thro’ 100 mesh.	58.0 “		
	98.5		100.5

Hardinge Conical Mill, working on roll product, charged with one ton of pebbles, consuming 15 H.P. and producing over 3 tons per hour:—

Feed.		Product.	
On 10 mesh ...	25.3 p.c.	On 60 mesh ...	1.4 p.c.
“ 20 “ ...	38.2 “	“ 80 “ ...	5.5 “
“ 40 “ ...	12.2 “	“ 100 “ ...	2.5 “
“ 60 “ ...	6.6 “	Thro’ 100 mesh.	90.8 “
“ 80 “ ...	5.5 “		
“ 100 “ ...	2.3 “		
Thro’ 100 mesh.	9.5 “		
	99.6		100.2

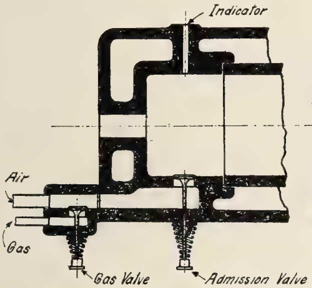
THE EXPERIMENTAL GAS ENGINE IN THE THERMODYNAMIC LABORATORY, UNIVERSITY OF TORONTO

W. W. GRAY, '04.

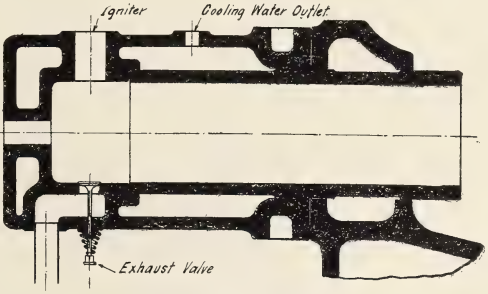
Demonstrator in Thermodynamics.

This engine was built by Fielding and Platt, Gloucester, England, and was installed in the laboratory in 1906. It is a single cylinder, single acting, horizontal engine, operating on the Otto cycle, and is rated at 9 B.H.P. at 240 R.P.M.

Fig. 1 is a horizontal section through the cylinder, showing gas and admission valves. These valves are of the common mitre type. They are held down on their seats by springs, and are operated through levers by cams on a side shaft, this shaft being driven by spiral gear from the crank shaft at half the speed of the latter. Fig. 2 is a vertical section through the cylinder. The exhaust valve is of the same construction as the gas and admission valves, and, like them, is driven by a cam on the side shaft. The springs on all the valves are adjustable, and the valve stems are fitted with adjusting heads, so that the times of opening and closing of any port are under complete control.



Horizontal Section through Cylinder.
Fig. I



Vertical Section through Cylinder.
Fig. II

The cycle of the engine is complete in four strokes of the piston. During the suction stroke a mixture of gas and air is drawn into the cylinder, the admission port being open throughout the whole stroke, and the gas port during just the middle part of the stroke. The mixture is compressed during the next stroke into the clearance space. At the end of this compression stroke the mixture is caused to explode, the pressure rising almost instantly to its maximum. Expansion takes place during the third stroke, the piston being forced forward. The exhaust port is open during the fourth stroke, and the spent gases are expelled from the cylinder. This exhaust stroke completes the cycle.

The governor is of the rotary ball type, and is driven by bevel gear from the side shaft. The engine is governed on the "hit-and-miss" principle, the governor acting on the gas valve. The gas valve is operated by a cam and lever, but indirectly through a block controlled by the governor. Should the speed require it, the governor allows this block to remain between the valve stem head and the cam lever, and the lever hits the block, and the valve is made to open the port every time. Should the speed rise above the normal the governor lifts the block, the cam lever misses the valve stem head, and nothing but air is drawn into the cylinder, the governor is so arranged that the engine may be run at any speed from 125 to 300 R.P.M., adjustment may be made while the engine is in operation.

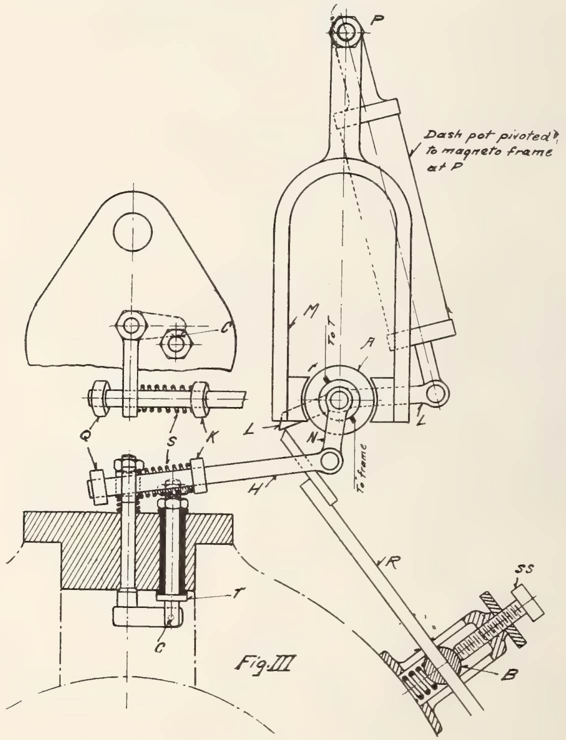


Fig. III

Three methods of ignition may be used on the engine: the hot tube, the jump spark, and the "make-and-break." Of these the most satisfactory is the "make-and-break." This method may be understood by referring to Fig. 3. *M* is a magneto mounted on a bracket on the cylinder. *LL* is keyed to the shaft of the shuttle wound armature *A*. *N* is a crank keyed to the other end of the shaft. The rod *R*, driven by an eccentric on the side shaft, engaging with *LL*, rotates the armature in the same shown by the arrow. At the same time the collar *K* on the rod *H* compresses the spring *S* against the crank *E*, and contact is made at *C*. When the end of *R* slips off the end of *LL*, the armature is jerked back by the dash-pot and a current is generated at the same time that the rod *H* is brought back and the collar *Q* strikes *E*, and contact at *C* is broken. This produces a strong spark, one terminal of the magneto being connected to *T*, an insulated plug, and the other to the engine at a convenient point. *SS* is a set screw by which the spark may be set to occur at any desired time. The ball *B* acts as a guide to the rod *R*, and its position fixes the time when *R* will disengage from *LL*. The spring keeps the ball against the set screw, and by turning the screw in or out the spark may be made earlier or later. This igniting device is in common use on European engines, and is most satisfactory. It seldom fails, and the spark is under complete control, and may be set while the engine is running.

The engine may be converted into an oil engine by disconnecting the gas gear and attaching a vaporiser and accompanying fittings. In this case the governor acts on both the vapor valve and the oil pump, and the charge ignites on compression without the use of the spark.

The accompanying table contains the results of a series of tests recently made on the engine. Indicator diagrams were taken at intervals during some of the tests, and the indicated horse power calculated. A Crosby special gas engine indicator was used with a 200 spring. This spring was too strong to allow the exhaust and suction lines to appear on the diagrams. A 10 spring was put in the indicator and diagrams taken, from which the loss of mean effective pressure due to exhaust and suction was found to be 2.5 pounds per square inch. This loss was taken into account in calculating the *I.H.P.* The brake horse power was measured by a simple friction brake on an internally water-cooled pulley. The mechanical efficiency, expressed as a percentage, was obtained thus:—$\frac{B.H.P.}{I.H.P.} \times 100.$

The gas consumed during the tests was measured by a service meter of the Consumers' Gas Company, calibrated under Government inspection. The ratio, volume of air to volume of gas, was determined by the following method: The total volume of mixture drawn into the cylinder per minute is piston displacement multiplied by the number of strokes of gas valve per minute. The volume of gas drawn into the cylinder

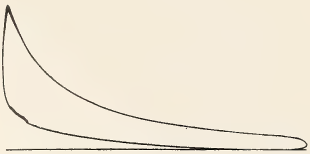


Fig 1

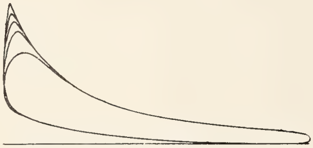


Fig 2

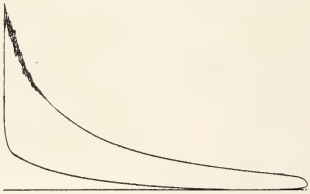


Fig. 3

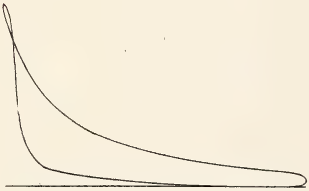


Fig. 4

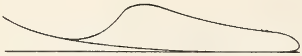


Fig. 5

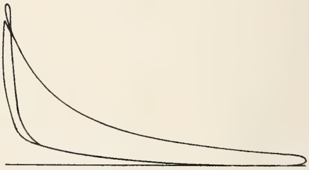


Fig. 6

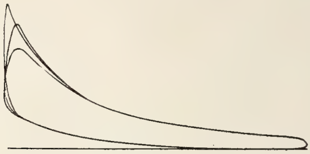


Fig. 7

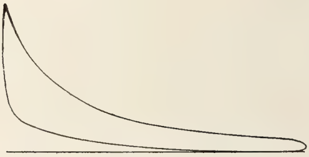


Fig. 8

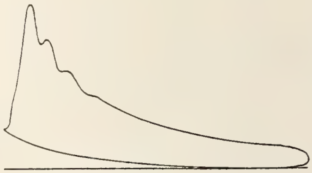


Fig. 9

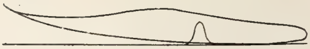


Fig. 10

per minute was measured by the meter. The difference between the two volumes is the volume of air per minute.

The heating value of the gas is the higher heating value as determined by a Junker's gas calorimeter.

The results, *B.T.U.* per minute per *B.H.P.*, were determined thus, taking test No. 1 as an example:—*B.T.U.* per minute per

$$B.H.P. = \frac{19.1 \times 620}{60} = 197.$$

The heat efficiencies were determined as follows, again taking test No. 1 as an example:—Heat efficiency $= \dfrac{33000 \times 100}{197 \times 778} = 216\%$

Examples of indicator diagrams taken from the engine are shown in the accompanying plate. Fig. 1 shows a diagram made by thirty consecutive tracings of the pencil. This shows a mixture as nearly perfect as can be obtained. The next diagram was taken with too little gas in the mixture. Fig. 3 shows the effect of too much gas. Early ignition produces a diagram as shown in Fig. 4, while late ignition gives a diagram such as Figs. 5 and 10. In Fig. 10 is shown a "back-fire," due to late ignition. Combustion is not complete before exhaust, and the unburned gas explodes in the exhaust pipe during the exhaust stroke. Fig. 6 shows two diagrams taken with the same spark position for two speeds. The diagram with the loop was taken with engine running at 195 *R.P.M.* The same spark position gives a good diagram for a higher speed, 220 *R.P.M.* This explains why the spark should be retarded when one is starting a gas engine. Figs. 7 and 8 were traced from diagrams taken when the hot tube was being used to fire the charge, No. 7 having taken engine under half load, No. 8 engine under full load. Fig. 9 illustrates a condition under which a gas engine will pound even though spark be late. In this case too much

Tests on Fielding and Platt Gas Engine, University of Toronto—Faculty of Applied Science.

Dia. of Cylinder—7.0 ins. Stroke—13.94 ins.
Clearance—24% of piston displacement.
Compression—90 pds. per sq. in. gauge.
Toronto illuminating gas—Electric ignition.

No. of Test	R.P.M.	Power		Mech. Effy.	Cu. ft. Gas per hr. per B.H.P.	Ratio Air/Gas	B.T.U. per cu. ft. Gas	B.T.U. per min. per B.H.P.	Heat Effy per B.H.P.
		I.H.P.	B.H.P.						
1	193	9.8	8.64	88.1	19.1	9.3	620	197	21.6
2	192	10.02	8.59	85.7	18.3	9.9	"	189	22.4
3	193	10.15	8.64	85.3	19.7	9.7	"	204	20.8
4	192	—	7.85	—	19.9	9.8	"	206	20.6
5	194	—	7.18	—	20.8	10.2	"	215	19.3
6	221	—	9.38	—	19.7	—	"	204	20.8
7	221	11.1	9.38	84.5	18.9	—	"	195	21.7
8	218	—	9.27	—	19.9	—	"	206	20.6
9	219	—	9.29	—	18.8	—	"	194	21.9
10	219	—	9.29	—	19.1	—	"	197	21.6
11	212	8.8	7.44	845	31.1	6.0	"	321	13.2

gas was supplied to the engine and a sharp knock was the result.

In all the tests excepting No. 11, the gas throttle was set by means of the indicator, so that a diagram such as Fig. 1 was obtained. The pencil was allowed to run over the diagram in some cases as often as fifty times, yet so nearly perfect was combustion that the diagram appeared as a single tracing. The condition for maximum efficiency may be thus obtained. In test No. 11 the indicator was not used to set the gas throttle; the mixture contained too much gas, and consequently there is a high gas consumption per *B.H.P.* and a low efficiency.

SOME NOTES ON THE MANUFACTURE OF STEEL RAILS, HAVING SPECIAL REFERENCE TO THE EDGAR THOMSON PLANT, PITTSBURG

J. ST. LAWRENCE, '08.

To arrive at the finished product there are two fundamental processes. First, the reduction of the ore in the blast furnaces, and secondly, the conversion of the molten iron into steel.

The purpose of the following paper is to outline this latter process.

The blast furnace plant consists of eleven furnaces of the most modern type, the output of each being about 500 tons per twenty-four hours.

The molten iron is tapped from the furnaces at intervals of four hours, and run into hot metal cars; these cars have a capacity of about thirty tons and are so constructed that the ladle may be caused to tip and unload contents by the turning of a worm shaft.

When filled from the furnace the cars are coupled to a locomotive and drawn over to the mixers. Opposite the intake hole the car is stopped and its contents poured into mixer.

These mixers are rectangular steel enclosures, lined with fire brick and balanced on trunions. They have a capacity of about 200 tons and this tipping mechanism is controlled by hydraulic power.

The mixers serve a two-fold purpose; they provide a means of supplying to the Bessemer converters a metal of uniform quality, and they also serve as a store for the molten metal, during a temporary break-down at the converter plant. The mixers are so located that a track runs above and below their level, the upper track being for the purpose of conveying the metal from furnace to mixer, and the lower track to take metal from mixer to converter plant. Situated thus, "gravity" aids in removing metal from car on upper track to mixer, and by tipping mixer on trunion the same force aids in filling car on lower track.

After the metal has been in the mixers from four to six hours it is poured into cars placed on the lower track and sent to the

Bessemer converter plant. Here is where the steel-making process really begins. The converters, four in number, are somewhat pear-shaped; sheeted with ½″ steel plate and lined with silicious rock and fire clay.

The converters are balanced on trunions, one of which is hollow and through this hollow trunion the blast is blown. From here it is piped to the bottom and admitted up through the tuyeres. Owing to the fact that the lining of the bottoms wears out much faster than the lining of the sides, the converters are so constructed that the bottoms are interchangeable and may be replaced with little labor. These bottoms are made of refractory brick or of rammed plastic material about two feet thick, steel encased. In this bottom the tuyeres are embedded in such a manner that the air holes are vertical. The tuyeres are made of circular brick, two feet long and six inches in diameter. Throughout the length there are about a dozen round holes, three-eighths of an inch in diameter; through these holes the blast is blown.

When the bottoms are newly "baked," these tuyere brick just come flush with upper surface. The blast necessary is supplied by Allis-Chalmers blowing engines, delivering it at a pressure of from twenty to twenty-three pounds per square inch. The process here employed is the "acid," and as no phosphorus is eliminated, this element must be kept low in the iron used. Such a grade of ore is used that this element does not exceed one-tenth of one per cent.

Sulphur, if present to any extent, is another element that produces undesirable effects in the rail, and in the iron from the furnaces this is kept low, seldom running above one-quarter of one per cent. By careful handling of the blast furnace this may be kept as low as two one-hundredths of one per cent. The molten iron also contains about three per cent. C. and from one to two per cent. Si. The presence of these two elements makes possible the manufacture of steel by this process. The iron also contains some manganese, but the heat evolved by the oxidization of this element is much less than that evolved by the former two, and so, in this connection, is of less importance.

TO CHARGE THE CONVERTER

The hot metal car is drawn up on the elevated track which runs parallel to the row of converters, the car is stopped oposite to the converter to be charged which has been tipped over into horizontal position to "receive." By a similar means to that employed at the mixers, the ladle of car is made to tip, delivering its contents to the converter.

The converter is now nearly in a horizontal position with the molten metal lying in the "belly" of the vessel. The blast is now turned on and the converter brought to a vertical position; the oxidization of the elements present has now commenced. To complete this process usually requires from ten to twelve minutes. This may vary a little, depending on the initial state of the converter (whether hot or cold) and also on the percentage of the elements present. As will be seen later, the percentage of silicon has the greatest effect on producing heat. With a low initial temperature, the elimination of the silicon is almost complete before the carbon is seriously affected, but there is a critical temperature where the relative affinities of silicon and carbon for oxygen are reversed, and when this is attained the silicon immediately ceases to have preference and the carbon seizes all of the available supply of oxygen. This continues till the carbon is reduced to about .03 per cent.

If the carbon is oxidized first, due to a high initial temperature, the "blowing" may be continued after the "drop" of the "carbon flame" and the silicon will be oxidized in preference to the iron itself.

In America this practice is not followed; it is considered better to eliminate the silicon early in the process, using scraps added to the charge or steam in the blast to reduce the temperature if necessary. The loss from "blowing" with converters of this size is from 8 to 10 per cent. Assuming the loss to be 8 per cent. and that the elements present as C., Si. and Mn., etc., do not exceed 5 per cent., we then have 3 per cent. of iron lost.

Analysis of the slag shows that three-quarters of one per cent. of the total output is held as "shot" and as this is not recovered, it represents a dead loss. Also about 1.8 per cent. is chemically united with the silicon in the slag. Then as losses in the slag we have approximately 2.5 per cent. To make up the total loss we have yet to account for 5 per cent. and this is mainly lost in being ejected from the nose of the converter, in the form of splashings.

The final temperature of the converter is about 1675° *C.* and may be accounted for thus:

Heat of metal on charging	1400° *C.*
Rise of temp. due to oxidization of elements	325° *C.*
Loss due to radiation	50° *C.*
Final temperature	1675° *C.*

The following table is taken from a recent work by Campbell on the manufacture of iron and steel, and shows the part played in the heat development by the different elements present. We have noted before that the oxydization of silicon had the greatest effect on producing heat. From the table we see that the surplus heat evolved by the oxidization of 10 kgs. of Si. is greater than that given off by 35 kgs. of C.

Calorific History of the Acid Converter.

Data:—1000 kgs. pig iron — Si. 1.0 p.c. — C. 3.5 p.c. Initial temp., 1400° *C.* Average temp., 1600° *C.* Loss 8 p.c. — metallic iron burned 2 p.c.

Specific heat at 1600° *C.* per kilo. liquid steel = 0.21 — liquid slag = 0.25 — lining = 0.25

CO and N = 0.32 and CO_2 = 0.68
Specific heat of air 100° to 1400° per kilo = 0.268

Net Heat Development.

	Calories developed.	Surplus.
Combustion of silicon—		
10 kgs. Si. + 11.4 kgs. O = 214 Si. O_2 =	64140	
11.4 kgs. O = 49.6 kgs. air absorbing		
49.6 × 0.268 × 1300 =	— 17280	46860
Combustion of iron—		
20 kgs. Fe + 5.7 kgs. O = 25.7 Fe O =	23460	
5.7 kgs. O = 24.8 kgs. air absorbing		
24.8 × 0.268 × 1300 =	— 8640	14820
Combustion of carbon—		
7 kgs. C. + 18.7 kgs. O = 25.7 kgs. CO_2 =	56930	
28 kgs. C. + 37.3 kgs. O = 65.3 kgs. CO =	68600	
56 kgs. O = 243 kgs. air absorbing		
243 × 0.268 × 1300 =	84830	40700
Total surplus heat developed		102380

Calorific Capacity of the Products.

Wt. × specific heat at 1600° *C.*

920 kgs. liquid steel × 0.21	= 193.2
150 kgs. liquid slag × 0.25	= 37.5
50 kgs. lining × 0.25	= 12.5
25.7 kgs. CO_2 × 0.68 × ¾	= 13.1
65.3 kgs. CO × 0.32 × ¾	= 15.7
244 kgs. N × 0.32 × ½	= 39.2
Total capacity for 1° *C.*	311.2

Theoretical rise in temperature = $\frac{102380}{311.2}$ = 329° *C.*

With the metal in converter brought to a proper condition, it is ready to be poured into ingot moulds. First the converter is tipped over and the blast shut off; the converter is now further tipped, allowing its contents to run into a ladle. During the operation the "spiegel" is added. The "spiegel" is a pig iron containing about 12 per cent. of Mn. For every ten tons of rail steel, about one ton of "speigel" is used; this gives enough manganese to roll well and sufficient carbon to confer the necessary degree of hardness. This "spiegel" is melted and prepared in a cupola near at hand. The ladle into which the molten steel from converter is poured, is mounted on wheels and rests on a track supported by the horizontal arms of a hydraulic crane. When the ladle is filled, the crane is elevated vertically, then it swings round till its horizontal arms engage with other projecting structural work, on which rests a track.

The track on crane arms and that on structural work now form a continuous way over which the mounted ladle is pushed by means of a hydraulic cylinder and ram, located behind ladle on crane arms.

The ladle is so constructed that the metal is poured from the bottom; this is accomplished by having a small hole in bottom, the cover of which is operated by a lever outside.

TO FILL THE INGOT MOULDS

The moulds, each mounted on a little car, are run beneath the ladle and as they come opposite the hole in ladle, the operator raises the lever, allowing the molten metal to run out.

Besides forming a very convenient method of filling the moulds, the hole in bottom serves another purpose. The slag being lighter than the metal, rises to the top; hence pouring from the bottom serves to make the separation almost complete.

The ingot moulds have an inside base measurement of 19″x 19″ and are 17″x 17″ at the top by 5′ 10″ long. They are made of cast iron, about 2½″ thick, and each mounted on a little car. The car is so constructed that its top forms the bottom of mould. On the sides of moulds are cast projections which aid in removing the mould from ingot.

The string of moulds, now filled, are coupled to a locomotive and drawn out on a siding where they are allowed to remain until the metal solidifies sufficiently to handle. When this condition is attained, the string of moulds are drawn over to the "stripper." The purpose of the "stripper" is to remove the mould from the ingot. This device resembles somewhat a travelling crane, in that it runs along on a track above and is operated by electricity in a similar manner. In place of the hoisting chain we have two long arms hanging down, which can be raised or lowered; through the lower ends of these arms are holes which are made to slip over the projections on side of mould.

To remove the mould the stripper is brought directly over the ingot and the holes in hanging arms are slipped over projections on side of mould; then a central arm is lowered to bear firmly on the ingot; with this central arm pressing down, the side arms are elevated, carrying up the mould, leaving the ingot on car. The ingot is still red hot but owing to the unequal condition throughout, it must be further treated before being passed to the bloom mill.

With the moulds now removed, the ingot is mechanically picked up by a travelling crane and taken to the soaking pits, nearby. These "soaking pits" are simply fire brick enclosed, reheating furnaces. They are twenty in number and located below the floor level, the sliding door on top being mechanically operated. Each of the pits has a capacity of eight ingots. The temperature is kept at from 2200° to 2300° Fahrenheit. The fuel used is natural gas, which is piped from West Virginia.

The ingots are allowed to remain in "soak" upwards of two hours. When ready to be removed, the sliding door on top is drawn back and a crane with a grappling device is lowered from a track above; the grappling device securely grips the ingot, and is then elevated. This crane deposits the ingot in the ingot carriage, which runs on track beside the pits. The ingot carriage conveys the ingot to the bloom mill; it is operated by electricity, the conducting wire being below and between the rails. This carriage and its run-way is so designed that when the carriage reaches the bloom mill end of its travel, it is caused to partly overturn, throwing its burden on the mill table. The centre of gravity of the car has been changed by this unloading and it falls back on track, ready to make another trip. The bloom mill tables are two in number, one on each side of the mill. Each consists of a stiff outer frame about 18′ long and 6′ wide. Between the sides and across the width, run rollers. These rollers are about 12″ in diameter and are spaced about 20″ apart. Their purpose is to give motion to the ingot, the driving force being supplied from a small reversing engine, through spur and level gears. This little reversing engine is controlled by the "roller" so that he always has the travel of ingot under control.

The power for the main drive of the bloom mill is supplied by an Allis-Chalmers compound Corliss engine, developing upwards of 2500 horse-power. This engine is direct connected to the rolls and runs at about 80 *R.P.M.*

This mill is known as a "three high" mill and takes its name from the fact that it consists of three rolls placed one above the other. By this arrangement the main driving engine does not have to be reversed at every "pass." Instead the ingot is started through the first pass at the bottom; as soon as it passes through, it falls on the table on the other side. This table is now made to elevate, bringing the ingot to right height to enter upper "pass."

The rollers on this table are now set running in proper direction and the ingot is passed through. In the meantime the "near" table has been elevated and receives the ingot. This table is now lowered and during the lowering operation the ingot is mechanically shifted and placed in line for next "pass."

In all, the ingot is given seven passes and is reduced from a 19″x 19″x 17″x 17″ section to 8″x 8″. The lifting and lowering mechanism of the table is operated by hydraulic power, the machinery being all below the floor level, and controlled by the "roller."

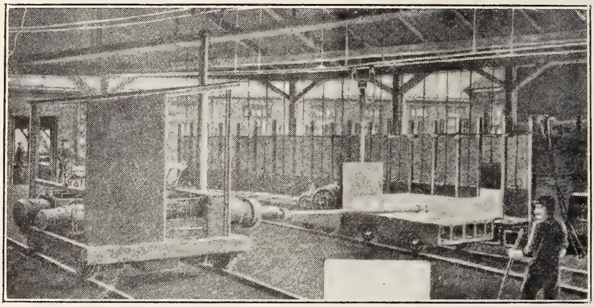
From the bloom mill the reduced ingot is passed along over carrier rolls to the shears, where the "crop end" is cut off, and where it is cut into "blooms" of the right length.

The "crop end" being low grade, due to piping and to impurities rising to top of mould, is of no further use here, and so is allowed to slide down a shute, where a car waits to receive it.

During the "bloom mill" rolling the metal has cooled considerably, so before the blooms are sent to the "roughing mill" they must be reheated. The bloom still on the line of roller carriers is conveyed to the end of the line. Here there is a switch, the purpose of which is to direct the bloom to one or the other of the two roughing and finishing departments. At the end of the line a small car receives the bloom. This car is capable of carrying about four blooms. With the car in position, the operator throws into motion a mechanism which shoves the bloom off the carrier rolls and on to the car. This car runs along on a track parallel to the row of reheating furnaces. These furnaces are of the ordinary brick enclosure type, having doors on either side; one side known as the charging end and the other the withdrawing.

To take the bloom from the car and place it in the furnace, a charging car is employed. This operation is shown in illustration. The charging car runs on a track parallel to bloom car track but at a distance from the furnaces greater than that of bloom car track. Thus the bloom car travels along between furnaces and charging car.

The motive power of charging car is electricity, but the rest of the mechanism is operated by air. To charge the furnace, the charging car is run opposite the bloom car, which has been properly placed opposite the door of furnace. The door is balanced so that by pulling a chain the operation of charging car may easily cause it to slide up. With the furnace door open, the long arm, shown in view, is made to move out, shoving the bloom into the furnace. The bloom is allowed to remain here until the desired temperature is reached, when it is withdrawn or discharged from the other side of furnace and sent to the roughing mill.



Method of charging retreating furnace

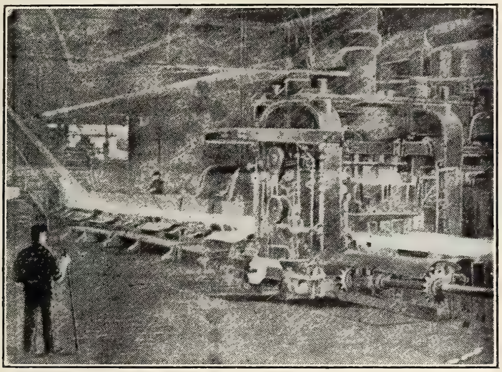
The discharging is accomplished by the aid of a "drawing car," resembling somewhat the "charging car," the essential difference being that on the long projecting arm there is a grappling device which is made to enter the furnace and draw the bloom out on to the bloom car.

On reaching the roughing mill table the bloom is mechanically removed from car and placed on table.

The roughing mill is also of the "three high" type, direct driven from a horizontal vertical Allis-Chalmers compound Corliss engine of about 2000 horse-power. The auxiliaries of this mill, including the lifting and lowering mechanism of tables, are operated similarly to the bloom mill auxiliaries.

Here the bloom is roughed to a section approximating that of the desired rail. This requires five passes.

Leaving the roughing mill it is carried along on a straight line of roller carriers to the intermediate mill, where it is given five passes. The intermediate mill is also of the "three high" type, but the lifting table is of a somewhat different design. Instead of the whole table elevating, it is pivoted at one end, that part being nearest the mill raising and lowering.



Rolling the Rails

The rail has now in process of rolling reached a considerable length, probably sixty-five feet, and so to economize in floor space and for other mechancial reasons, the semi-finished red-hot rail is made to run up a shute, as it takes the intermediate passes. On the last pass it is again allowed to go on the line of roller carriers and is delivered to the cooling tables. This cooling process has been made necessary in recent years by the increased size of the rails rolled. In former years the practice was to pass the rail direct from the intermediate to the finishing mill, but as larger sections were required, this practice did not give good results. After much experiment, the cause was found to lie in the fact that the larger rail section held the heat longer and so was being finished at a higher temperature. To overcome this, the cooling table was designed and located between the intermediate and finishing mills.

Owing to the fact that a greater amount of metal and heat is contained in the head of the rail than in the flange and web, the cooling, under ordinary conditions, would be unequal throughout. To guard against this, each rail is laid on the cooling table on its side, with its head against the flange of the rail in front of it, the exchange of temperature between the adjacent parts being such as to cause all parts of rail section to cool off at approximately even temperature. Each rail remains on the cooling table from three-quarters to one-and-a-half minutes, depending on the size of the section; it is then passed to the finishing rolls, where it is brought to exact size. This cooling process is said to give a heavy rail, in every way as satisfactory as the light rail of former years.

After leaving the finishing rolls, the rail is passed along by roller carriers to the "hot saws," where it is cut into the required length, the rails being cut somewhat longer than the finished length to allow for contraction in cooling. These hot saws are three in number, about thirty inches in diameter, and are mounted on a mandrel about seventy feet long, the saws being spaced apart a distance corresponding to length of rail required. This device is so designed that the mandrel carrying saws may be made to swing up or down, about a pivot. The saws are kept running all the time and as a rail comes into position the mandrel is caused to swing down, the saws cutting the rail into desired length.

Leaving the "hot saws," the rail now passes to the "hot beds." Here the rail is allowed to remain until cool enough to handle. The "hot bed" is simply a frame made of rails placed at right angles to run-way. As the rail comes down the run-way it is mechanically pushed over on the bed.

After cooling here, the rail is sent to the straightening department, where it is passed through a press, the same being allowed to strike it where necessary to remove bends.

From here it is passed over roller carriers to the drilling machines where the bolt holes in web are drilled. The burrs are then removed and the rail is ready for inspection before being shipped.

REFINING OF SILVER BULLION CONTAINING ARSENIC AND ANTIMONY

B. NEILLY, '07

The following work was suggested by a paper on "The Refining of Gold Bullion," by Dr. T. Kirk Rose, in 1905, and found in Vol. 14, Transactions of British Institute of Mining and Metallurgy.

In his experimental work Dr. Rose did not confine himself wholly to gold bullion but proceeded to show that even in the case of silver bullion the base metals could be oxidized off by passing a stream of oxygen through the molten metal. In his early work he used only pure oxygen but in subsequent experiments he used air and found the results obtained were quite as satisfactory. In the case of gold he found that by this method it could be reduced to the pure state with very small losses.

The writer applied Dr. Rose's method to the refining of silver bullion containing arsenic and antimony, but found that it required very careful manipulation to prevent spitting. The pipe immersed in the molten metal gradually corroded away; the end broke off suddenly and the pressure being reduced particles of silver were projected out of the crucible. In addition to this the method was slow. After passing a current of air through the metal until the fumes apparently ceased to come off it was cast and assayed only 90 per cent. silver. It was again melted down and air passed through. At the end of ten minutes no fumes were visible, but on withdrawing the pipe and allowing the air to play upon the surface copious fumes began to rise at once. This method was continued and from the results that follow it would appear that blowing on the surface rather than through the metal is much more satisfactory.

The apparatus at our disposal consisted of a crucible furnace No. 6 and a Cyclone crucible furnace with air blast as manufactured by Fletcher, Russel & Co. The bullion was fused in Battersea graphite crucibles and the air was conveyed by a rubber hose from a Root's No. 08 blower driven by one-half h.p. motor. To the end of the hose was attached a 22″ fire clay pipe ¼″ in diameter (inside measurement) to convey the air down to the surface of the metal. This then was suspended from above in such a way that it could be raised or lowered through a hole in the asbestos top to any required position.

In order to get rid of any nickel, copper or cobalt present along with as much arsenic and antimony as possible, it was decided to form a speiss. The bullion was melted down in the cyclone furnace at a temperature of about 1140° C. and iron in the form of nails added until they were unattacked by the arsenic and antimony present.

The crucible was then removed and cooled suddenly. Under these conditions the speiss separated cleanly from the bullion. The bullion was again melted down at a temperature of about 1090° C. with enough flux composed of sand and borax (2:1) to form a thin covering on the top of the molten metal. The air with sufficient pressure to cause a depression of say one-quarter inch on the surface was then blown on the metal until the arsenic first and then antimony were all oxidized off and the bullion pure.

This end point is easily determined. Samples are dipped out and after cooling, hammered. If they are inclined to be brittle to the least degree the metal still contains some impurities. Even a small fraction of one per cent. impurity will cause it to crack. Again on becoming pure the molten metal changes from a white to a clear sea green in color.

The bullion used in the first five experiments assayed as follows: Silver, 80.9 per cent.; arsenic, 7.5 per cent.; antimony, 9.6 per cent. Nickel and cobalt not determined.

Experiment No. 1.

It was in this experiment that Dr. Rose's method of passing the air through the molten metal was tried with the results as before stated. At the end of 2 hours, 10 minutes, the silver content was only 90 per cent. The air was then blown on the surface and at the end of another 3 hours the metal was pure.

Summary—

Silver content of original bullion, 1974 × 80.9 =		1596.9	grs.
Final wt. bullion		1573.0	“
Loss from all causes		23.9	“
Loss up to end of speissing		15.5	“
Total loss of silver	1.5 p.c.		
Loss up to end of speissing	0.9 “		
Loss due to volatilization, slag, etc.	0.6 “		

Since the speiss obtained weighed 326 grs. and assayed 0.47 p.c. it contained 1.5 grs. and the other 14 grs. must be charged to spitting and other forms of mechanical loss.

Experiment No. 2.

General method used and time required for blowing was 3 hours and 40 minutes.

Summary—

Silver content of original bullion, 2750 × 80.9 =		2224.7	grs.
Final wt. of pure silver		2207.54	“
Loss due to all causes		17.16	“
Total loss in silver	0.77 p.c.		
Loss up to end of speissing	0.11 “		
Loss due to volatilization, slag, etc.	0.6 “		

Experiment No. 3.

Used general method but tried to speiss with magnetite without success, in the end having to remove it. Again used pure borax as flux. Time required for blowing was 3 hours 40 minutes.

Summary—
Content of original silver bullion, 2000 × 80.9 = 1618 grs.
Final wt. pure silver .... 1602 "

Total loss from all causes .... 16 "
= 0.98 p.c.

In this case the crucible was badly corroded and no doubt some of the loss occurred in removing the magnetite.

Experiment No. 4.

In this case did not speiss but began blowing at once. At the end of 1 hour and 20 minutes it assayed 87.8 p.c. and at the end of 4 hours it ran 96 p.c. It still required 2 hours to bring it to the final state.

Summary—
Silver content of original bullion, 2290 × 80.9 = 1852.6 grs.
Final wt. pure silver .... 1836.2 "

Total loss for all reasons .... 15.4 "
= 0.9 p.c.

The total time required here was 6 hours. From this it would appear that the speiss is useful if only for the removal of some of the antimony.

Experiment No. 5.

Followed general plan carefully assaying the slag and speiss. The time required for blowing was 3 hours, 45 minutes.

Summary—
Silver content of original bullion, 2509 × 80.9 = 2029.7 grs.
Final wt. of pure silver .... 2007.7 "

Total loss for all reasons .... 22 "
Total loss = 1.08 p.c.
Loss due to speiss .... .08 p.c.
Loss due to slag .... .13 "

Loss due to volatilization, etc. .... 0.87 "

In this case the crucible broke and in recovering the bullion there must have been some mechanical loss.

Experiment No. 6.

General method used. The bullion in this case assaying 88.7 p.c. silver and containing as its impurity mostly arsenic with very little antimony. Time required to blow, 3 hours.

Summary—
Silver content of original bullion, 2530 × 88.7 = 2244 grs.
Final wt. of pure silver .... 2222 "

Loss for all reasons .... 22 "
Total loss .... 0.98 p.c.
Loss due to speissing .... 0.13 "

Loss due to volatilization, slag, etc. .... 0.85 '

Experiment No. 7.

This was by all odds the most careful and complete determination made. Starting with a bullion assaying 80.15 p.c. silver, the impurities being arsenic and antimony, the general method was used.

Summary—
Silver content of original bullion, 2546 × 80.15 = 2041 grs.
Final wt. of pure silver .... 2025 "

Total loss for all reasons .... 16 "
Total loss = 0.79 p.c.
Loss due to speiss .... 0.08 p.c.
Loss due to slag .... 0.12 "

Loss due to volatilization, etc. .... 0.59 "

In the first five experiments the bullion after speissing assayed between 83.2 and 83.8 p.c. and on remelting and adding more iron it was found impossible to raise the silver content. The same remarks apply to the bullion containing mostly arsenic as its impurity after being speissed up to 94.02 p.c. Apparently the affinity of iron and silver for arsenic and antimony is equal at this stage.

Summarizing the results without taking into consideration Experiment No. 1, it is found that the average total loss, allowing for everything = 0.88 p.c. To this say the speiss contributed 0.1 p.c. and the slag 0.12 p.c. Then the loss due to volatilization and to the fact that certain small amounts are carried over mechanically, is placed at 0.66 p.c.

No attempt was made to collect the flue dust but on disconnecting the furnace and scraping out the flue a sample of 200 grs. was collected that assayed 2.2 p.c. silver. On volatilizing some of this in an open tube small particles of metallic silver were left behind, showing that some of the silver had been carried over mechanically.

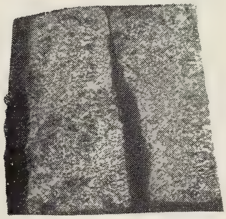
In Plattner's Rostprogesse, losses due to the oxidization of silver at high temperatures are dealt with largely.

First he records that in passing hydrogen or carbon dioxide over silver at high temperatures there was no loss. In heating silver exposed to air in the presence of arsenic and antimony the losses were not so high as where sulphur, iron or copper was present. He reasoned that the silver on being heated first changes to the oxide. Now when arsenic and antimony are present they unite with the silver oxide to form arsenates and antimonates and are themselves oxidized, thus protecting the silver.

After the arsenic and antimony have been removed the loss becomes heavy. Dr. Rose found that on passing oxygen through 10 grs. of molten silver for 40 minutes the loss was as high as 8 p.c.

Plattner exposed a finely powdered smaltite ore carrying about 50 ozs. to the ton in silver, to a high temperature and collected the flue dust in a long pipe. Two feet from the furnace residue assayed 10 p.c. silver value of ore; 12 feet, 4 p.c.; 36 feet, 2½ p.c.; 98 feet, 1-10th p.c. In this dust he found a portion of the finely divided ore and on investigating concluded that the mechanical loss was proportional to the amount of finely divided material carried over. Later he mixed finely divided silver with powdered quartz and his loss was over 10 p.c.

Bullion blown, 1 hr., 20 min.
Assays
Ag.—88.33% As.—2.3%
Sts.—9.54% by diff.



Fracture of Silver Bar
Assaying
Ag.—99.2%

After many experiments such as these, Plattner concluded that the loss due to volatilization and mechanical means was influenced largely by the amount of surface exposed.

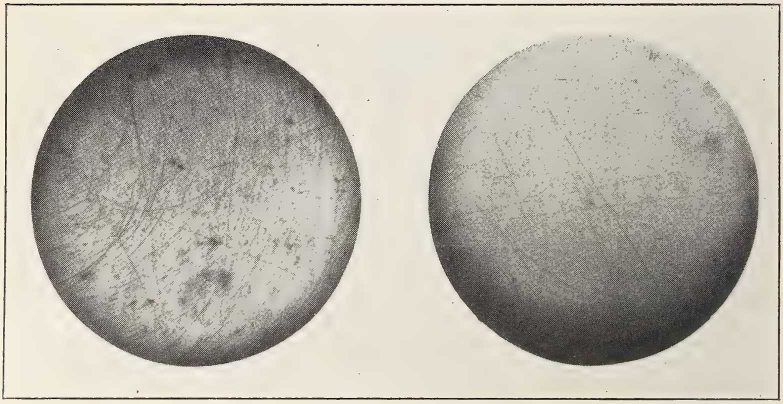
Now in the method described in this paper only a thin covering of acid slag was used and the surface exposed is small since it depends wholly on the amount of slag displaced by the air blast.

Thirty per cent. of the total loss was due to the speiss and slag. This could be recovered by retreating in the blast furnace. The remaining 70 per cent. of the total loss is charged to volatilization and mechanical means and it would appear from

Plattner's experiment with flue dust that this could be greatly reduced by the use of a dust chamber.

No difficulty was experienced in refining the bullion to 99.985 p.c. and since the loss is exceedingly low and the cost of refining small, it looks as though it might be made use of commercially.

The photos below were obtained by polishing and etching samples taken from the bullion at different stages. The dark spots represent the impurities (arsenic and antimony) and the lines extending across the face are due to imperfections in polishing.



Original Bullion
Assays
Ag.—80.9% **Sts.—9.6%**
As.—7.4%
Co. and N, not determined

Refined Bullion
Assays
Ag.—99.985% **As.———**
Sts.———

PRESIDENT'S VALEDICTORY

Gentlemen:—As retiring President of the Engineering Society, it gives me great pleasure to thank you for your hearty co-operation during the past year. It has been a year full of new undertakings but one in which we have had a fair measure of success, and with your permission I will review the work covered:

The appointment of a paid secretary, which has long been suggested by past Executives, has at last been consummated through the co-operation of the Faculty Council. By this appointment a great increase in the variety and sale of supplies has been rendered possible and the Supply Department under the new conditions has been placed on a working basis.

The new monthly, "Applied Science," now replaces the old "Transactions of the Engineering Society," and from the hearty reception it has received from undergraduates and graduates, it fills a long-felt want. Through this publication future Executives will find the formation of an employment bureau made easy, and in fact some little preparatory work along that line has been done already.

During the past session sectional meetings, rendered possible under the changed constitution, have been held and have been well attended, a great many undergraduate papers being brought out by this means. The telephone question, which has been an issue in so many past elections, is now solved by the employment of a call boy, paid by the Society.

The annual dinner, held this year for the first time on University ground, was an unqualified success.

A new departure, which hardly falls under the Society's work, has been instituted in a manufacturers' exhibit which it is hoped will be broadened by the incoming Executive. Certain exhibits have been already secured and will be mounted and placed in the halls before the coming fall. These will no doubt be of great interest to all the undergraduate body.

The Faculty Council have been impressed with the desirability of having smoking and reading rooms in the new buildings which are to be erected, and I believe it is their intention to provide these.

The constitution of the Society has been revised and it is now believed to be in permanent condition. Two changes worthy of note are, the year Representatives being thereby Presidents of their years, and the President of the Society, the representative of the students of the faculty on the Executive of the Undergraduates' Parliament. By this means it was felt that the faculty would be brought in closer touch with the University and it was also desirable for the Society to have an intimate connection with the year organizations. As a member of the Executive of that Parliament, the President will be enabled to watch over the interests of the undergraduates in the faculty, and the year representatives as presidents of their respective years will produce harmony between the Society and the year organizations.

Much of the work which has been accomplished during the past year has been due largely to the strong Executive Committee with whom it has been my privilege to be associated. Your thanks is due them for the earnest and efficient manner in which they have discharged the duties of their several offices.

In closing, allow me to thank you for the honor you have done me in placing me in this position, and I sincerely hope that during the past year I have in some small measure merited the confidence you placed in me last spring.

I have much pleasure in presenting to the Society their President-elect for 1908-09, Mr. R. J. Marshall.

Yours sincerely,

THOMAS H. HOGG.

TREASURER'S REPORT

Mr. President and members of the Engineering Society: I beg to make the following report of the financial standing of the Society on the completion of the business for 1907-08:

Receipts.

Resources realized from 1906-07—		
By cash on hand, April 1st, '07	$331.67	
By advertisement pamphlet No. 20	241.00	
By outstanding account received	20.60	
By percentage of fees, '06-'07	465.00	
	———	$1,058.27
Receipts for business, '07-'08—		
By part of fees '07-'08	665.00	
By annual grants 1907 and 1908	100.00	
By past fees, held by faculty	399.75	
By other fees	2.00	
	———	1.166.75
By receipts from annual dinner		821.74
By sale of supplies		5,120.53
By subscriptions to Applied Science		58.00
		$8,225.29

Disbursements.

Liabilities incurred by previous executive—		
To presentation to retiring president	$ 50.00	
To damages at elections, March, ’07	47.00	
To other bills	32.98	
To cost of pamphlet No. 20	870.87	
		1.000.85
Running expenses, ’07-’08—		
To representatives to other colleges	80.00	
To annual elections	89.50	
To printing and stationery	34.27	
To expenses of meetings	42.10	
To flowers, phone and sundries	113.76	
		359.63
To cost of annual dinner		819.41
To purchase of supplies	4,856.25	
To expenses of supply department	221.44	
		5,077.69
To cost of Nos. 1, 2 and 3 Applied Science		637.98
Cash balance, May 1st, 1908		329.73
		$8,225.29

Resources.

Cash balance	$329.73
Remainder of fees, ’07-’08	56.00
Accounts due supply department	139.18
Advertisement due Applied Science	290.22
Cost price, stock on hand in supply department, March 15th, 1908	1,269.31
Other debts due Society	60.00
	$2,144.44

Liabilities.

Outstanding accounts in supply department	150.00
Other outstanding accounts	84.75
Estimated net cost of Nos. 4, 5 and 6 Applied Science	285.00
Surplus	1,624.69
	$2,144.44

It will be seen that the Society has handled a turn-over of $8,000 on a capital of a few hundred and the Executive has been considerably hampered in its operations in consequence, especially in starting new enterprises.

The actual resources of the Society at the beginning of the year amounted to $512.77 after meeting existing liabilities.

Our thanks are due to the Secretary of the Faculty for the accommodation that has been extended to us in carrying through the business of the year.

We have endeavored to place the Society on a more satisfactory footing and the net resources as shown in statement terminating this year's business are $1,624.69, or an increase of $1,111.92. The larger part of this is to be found in stock on hand, which has necessarily been considerably increased with the larger assortment of supplies now carried. It will also be noted that the pamphlet, which has heretofore been carried into the business of the following year, has been replaced by "Applied Science," which is paid for as it is issued, a much more satisfactory principle. With increased advertising and subscription lists, the loss on publications will also in all probability be greatly reduced now that this periodical is fairly established.

The Faculty have agreed to collect from each student a fee of one dollar for the Engineering Society instead of giving the Society 75 per cent. of the so-called library fee and this will mean a considerable increase in revenue.

We therefore hope that, so far as money can be used to strengthen the position of the Society, following years will find themselves well equipped.

A. F. WILSON, Treasurer.

AUDITORS' REPORT

We hereby declare that we, the undersigned Auditors, have examined all vouchers and audited all accounts and found them to be correct.

Owing to the extent and complex nature of the business handled by the supply department, we beg to recommend that in future a more elaborate and systematic set of books be kept in this department, and owing to the growth of the business, that a professional auditor be employed, as it takes so much time for the lay mind to become conversant with all the details.

We beg to recommend the improvement in the system of book-keeping employed in the general accounts over last year.

Auditors
S. R. CRERAR
GEO. E. QUANCE

Toronto, May 4th, 1908.

APPLIED SCIENCE

INCORPORATED WITH

Transactions of the University of Toronto Engineering Society

DEVOTED TO THE INTERESTS OF ENGINEERING, ARCHITECTURE
AND APPLIED CHEMISTRY AT THE UNIVERSITY OF TORONTO

Published Monthly during the College year by the University of Toronto Engineering Society.

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Editorial

This issue completes the first volume of "Applied Science." The step from a yearly to a monthly publication was taken only after careful consideration, and in spite of considerable pessimistic advice to proceed slowly, that neither material nor money was available to bring the venture to a successful issue.

Our optimism was justified. Financially, we are in a better position than last year. As to the quality of the contributed articles, our readers may be left to judge. We wish to take this opportunity of thanking our contributors, both graduates and undergraduates, for the valuable assistance they have afforded.

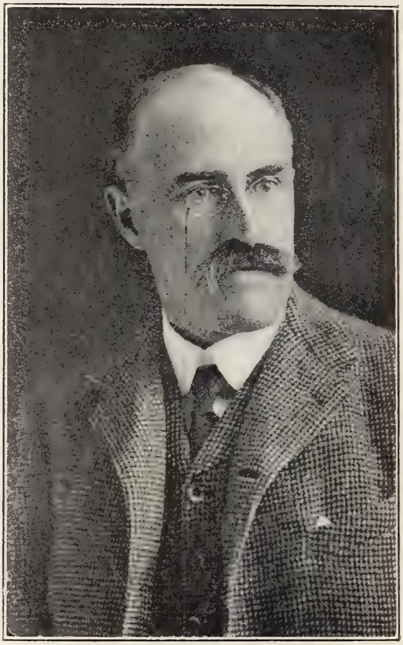
One of the chief reasons of our existence is to bring and keep the graduate more closely in touch with the institution. In this Applied Science has been eminently successful.

To the Graduates

Our subscription list has reached a very healthy state. However, a great number of men have neglected to send in their subscriptions. This has been due to carelessness. During the whole year we only met one graduate who felt he really could not afford the sum of fifty cents necessary to become a paid subscriber. Times are bad, but the financial stringency is hardly that severe. The revenue from subscriptions is only a small portion of our income. What we want is your assistance with the advertisers. At every opportunity boost Applied Science. If you ever do any business with our advertisers tell them where you saw their advertisement. It will help us all. Patronize our advertisers where possible. In a number of cases the concerns are managed by our own men. Next year we shall have a fair start and each number will be issued regularly, beginning in November and finishing in April.

J. Galbraith

President Canadian Society of Civil Engineers



W. F. Tye

Vice-President Canadian Society of Civil Engineers

It affords us much pleasure to print the following letter from

Canadian Society of Civil Engineers

T. Kennard Thomson, urging all School graduates and undergraduates to connect themselves with the Canadian Society of Civil Engineers. For some time there was a tendency to regard this body as an Eastern institution and of little interest to Western engineers. Lately, however, it has become truly national. Branches have been established in various centres, interest awakened, and strength gained which will go far towards raising the standard and furthering the interests of the profession generally in Canada. This year, quite by accident, three important executive positions are held by Toronto University men. Dean Galbraith is president; W. F. Tye, of Montreal, and G. H. Duggan, of the Dominion Coal Co., Glace Bay, are vice-presidents. A biography of Mr. Tye appears in "What Our Graduates Are Doing." We regret that it was impossible to procure one of Mr. Duggan.

New York, May, 1908.

" To the Graduates and Undergraduates of
The School of Practical Science.

Gentlemen :—

Every Canadian Engineer ought to belong to the Canadian Society of Civil Engineers just as every S. P. S. man ought to belong to the University of Toronto Engineering Society, and should keep all Societies of which he is a member posted as to his proper address to avoid losing good opportunities.

As our Dean, Dr. John Galbraith is now President, and two S. P. S. boys are Vice-Presidents of the Canadian Society of Civil Engineers, it seems to be an appropriate time to join.

Will you not write to C. H. McLeod, Esq., Sec. Can. Soc. C. E., 413 Dorchester Street, Montreal, Que., for application blanks and list of members ?

Yours sincerely,

J. KENNARD THOMSON.

WHAT OUR GRADUATES ARE DOING

Biography

Mr. William Francis Tye was born at Haysville, Ont., March 5th, 1861. He was educated at Ottawa University, and at the School of Practical Science, Toronto (1878 to 1881), and entered railroad service in 1882. From then until 1885 he served successively as rodman, leveler, transitman on location, and afterwards as assistant engineer on construction of the Canadian Pacific. During 1886 and 1887 he was transitman and assistant engineer on the St. Paul, Minneapolis and Manitoba. The next year he served as Engineer of Track and Bridges on the Tampico Branch of the Mexican Central. In 1890 he was locating Engineer of the Great Falls and Canada Railway in Montana, and in 1891 and 1892, Engineer in charge of location and Division Engineer of the Pacific extension of the Great Northern. For about two years he was in the west as engineer in charge of the change of gage of the Alberta Railway and Coal Company's road. In 1895 he was Chief Engineer of the Kaslo and Slocan Railway, and for four years following 1896, he held a similar position on the Columbia and Western. In 1900 Mr. Tye became Chief Engineer of Construction of the Canadian Pacific, in June, 1902, was appointed Assistant Chief Engineer of the system, and in May, 1904 was appointed Chief Engineer. In February, 1906, he resigned to take up the construction of electric tramways and power developments on his own account.

He is now Vice-President and Chief Engineer of the Canada Electric Syndicate, Limited, who are undertaking large power and tramway installations in Mexico.

Mr. Tye is a member of the American and Canadian Societies of Civil Engineers, and of the Maintenance-of-Way Association, and is a member of the St. James Club of Montreal, and of the Manitoba Club of Winnipeg.

R. W. Thomson, '92, has returned from South Africa and is now in charge of the Red Rock mine at Haileybury.

E. V. Neelands, '00, has resigned as resident manager of the Black Queen Mining and Reduction Co. at Crystal, Col., to take charge of the Ruthellan mine at Lake City, Colorado, for English capitalists.

T. K. Thomson, '06, has removed his offices from the Park Row Building, New York, to the Hudson Terminal Building. His business card gives the following record of experience: Ten years in structural steel with our best bridge companies, etc, starting as draughtsman and rising to chief engineer; as bridge engineer for railroad, had charge of the construction of 129 bridges; ten years in foundation work with best contractors, eight of which was chief engineer for well-known contractors; designed many of the largest and most economical caissons, and been in air chambers over 2,000 times; retained on over one dozen New York skyscrapers.

Geo. M. Bertram, '01, has been appointed local manager at Joplin, Missouri, for the Sullivan Machinery Co.

J. L. Morris, C.E., our first graduate, and W. J. Moore, '06, have formed the firm of Morris & Moore, land surveyers and architects, at Pembroke, Ontario.

C. H. Hutton, '08, is with the Dominion Electric Co.

D. J. McGugan, '07, is with H. H. Depew, '04, at the Crow's Nest Light, Heat and Power Co.'s plant at Fernie, B.C.

Mr. Norman Gibson, B.A.Sc., '01, of Winnipeg, has been appointed engineer of construction for the city of Brandon to superintend, under City Engineer Shillinglaw, the construction of the new cement bridge over the C.P.R. tracks and the Assiniboine River at First Street.

Mr. W. S. Gibson, B.A.Sc., '04, paid us a visit last week. Mr. Gibson has just returned from a two years' stay in Ceylon Island and Southern India, where he has been engaged with extensive experiments connected with the pearl fisheries.

R. E. W. Hagerty, '07, C. Murdoch, '06, J. A. Walker, '08, and a few others are going to the Yukon gold fields for the summer.

H. O. Hill, '07, is with the Riter Conley Co. at Allegheny, Pennsylvania.

E. D. Wilkes, '07, is with the Department of Public Works, Saskatchewan.

Great interest is being taken in the work of F. C. Baldwin, '06, and J. A. McCurdy, '07, in their endeavor to solve the problem of aerial navigation. Both are meeting with a considerable measure of success, "Casey" being apparently in the lead. Applied Science and all the graduates wish them every success.

Trafford Jones, B.A.Sc., '06, has entered the services of C. H. Mitchell, following hydro-electric work. He spent last year at mining in British Columbia.

M. H. Baker, '06, is with Metcalf Engineering Company at Midland.

M. Bates, '06, and O. Rolfson, '06, are with Laird & Routley at Haileybury.

H. M. Hyland, '07, E. Harrison, '07, have gone west on D. L. S. work.

A. L. Harkness, '06, has returned to his old position with the Dominion Bridge Co. at Montreal after taking his B.A.Sc. course.

F. R. Anderson, '07, E. G. Hewson, '08, Chas. Ross, '06, W. C. Jepson, '06, are on the Welland Canal staff.

A. C. Spencer, '07, is taking a special course in Germany, devoting his attention to producer gas engines.

J. A. Stiles, '07, is with the city engineer's staff at London.

O. L. Flanagan is pursuing similar work at Guelph, while A. Kinghorn, '07, and J. L. G. Stewart, '08, are similarly employed at Toronto.

J. M. Wilson is resident engineer for the Wood Products Company's new plant at Haliburton.

A. F. Wilson, '07, has secured a position with the Chicago Tedephone Co.

The Canadian Cement and Concrete Association was organized in Toronto on the 20th of April, 1908. The new association will work along similar lines to its sister organization, the National Association of Cement Users, in the United States. There is a wide field of usefulness in Canada for the new association. Manufacturers, contractors, engineers and architects are eligible for membership. In spite of its recent formation, a very healthy membership has already been acquired. The president-elect is Peter Gillespie, lecturer on Theory of Construction, of Faculty of Applied Science, and the secretary-treasurer, A. E. Uren, '05, at present editor of the Canadian Cement and Concrete Review. The offices are at 62 Church Street, Toronto.

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